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TECHNICAL CHANGE AND PROFITABILITY: THE LONG-PERIOD BEHAVIOR OF THE RATE OF PROFIT (COMPETITION, RATIONALITY)

BENIGNO VALDES
University of New Hampshire, Durham

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University of New Hampshire PH.D. 1986

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TECHNICAL CHANGE AND PROFITABILITY: THE LONG-PERIOD BEHAVIOR OF THE RATE OF PROFIT

by

Benigno Valdés
M.A. University of New Hampshire, 1983
Lcdo. University of Oviedo, 1979
B.A. University of Bilbao, 1976

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This dissertation has been examined and approved.

Richard W. England

Dissertation director, Richard W. England
Associate Professor of Economics

Walter F. Buckley

Walter F. Buckley
Professor of Sociology

R. Valentine Dusek

R. Valentine Dusek
Associate Professor of Philosophy

Marc W. Herold

Marc W. Herold
Associate Professor of Economics

Evangelos O. Simos

Evangelos O. Simos
Associate Professor of Economics

19 June 1986

Date

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ABSTRACT

TECHNICAL CHANGE AND PROFITABILITY: THE LONG-PERIOD BEHAVIOR OF THE RATE OF PROFIT

by

BENIGNO VALDES

University of New Hampshire, September 1986

This dissertation provides a theoretical inquiry into the effects of technical change on profitability. In the center of the discussion lies the Marxian 'Law of the Falling Tendency of the Rate of Profit' (LFTRP). The LFTRP maintains that mechanization, i.e. the introduction of cost-reducing techniques of the *capital-using-labor-saving* type, results in a lower average rate of profit. This proposition is denied by the Okishio theorem, which says that the introduction of such techniques is *incompatible* with a falling rate of profit.

In order to evaluate Okishio's claim, a model of the economy which incorporates fixed capital is constructed, and on its basis the following *THEOREM* is proven: *In the presence of fixed capital, if (i) capitalists choose innovations which lower the unit cost of production, and (ii) the introduction of more mechanized techniques raises the investment cost per unit of output, then the effects of mechanization upon the average rate of profit are theoretically indeterminate. Therefore, Okishio's claim is not generally valid.*

A *COROLLARY* of this theorem provides the necessary condition under which the LFTRP will actually hold. The condition is the following: *For mechanization to lower the average rate of profit, it must also lower some or all of the transitional rates of profit. (The transitional rate of profit is that which an innovative capitalist would obtain at ruling prices.)*

This corollary raises an important question: is there any possibility that the 'necessary condition' will be attained in the real world? Traditional teachings suggest that there is none, as those teachings assume that it would be "irrational" for any capitalist to introduce a more mechanized technique so long as it reduces his transitional rate of profit. Against this tradition, it is shown that *competition* might *force* the introduction of more mechanized techniques *even* if this implies a lower transitional rate of profit. This formulation of the problem is then compared with other treatments of the same subject in which the Okishio theorem is shown to be valid. It is argued that those treatments are inappropriate. The dissertation ends with a summary of the economic and political implications of the study.

INTRODUCTION

Whenever capitalism undergoes a serious economic recession, economists and politicians are quick to point out the reason, namely, that the rate of investment is lower than it used to be. When capitalists are asked what may be the cause for the lower rate of investment, their answer is always the same: the rate of investment is lower because so is the rate of profit. Therefore, economic crises appear to be the result of falling profitability. The question is, how does this fall in profitability arise? Basically, there are two contending explanations. One asserts that falling profitability is the result of a rising wage bill. The essential argument is this: in periods in which the strength of the labor movement increases greatly, wages tend to rise faster than productivity and hence the share of profits in national income tends to be "squeezed" by the rising share of wages. Thus, the rate of profit falls because wages rise too much. This explanation is called the "profit-squeeze theory of crisis."[1]

The alternative explanation sees the cause of falling profitability in the profit-seeking nature of capitalism. The basic argument is as follows. The urge for profit causes capitalists to engage in competition against each other. In the struggle, the immediate goal of each participant is to drive her rivals from the field and capture their share of the market. Different methods, such as advertising and even some forms of sabotage, are used with that intention. In the end, however, one capitalist

can secure a larger share of the market only by selling more cheaply than the other competitors, and to do so without suffering losses, by producing more cheaply. This is achieved by raising the productivity of labor with the continual mechanization of production. For the capitalists who move first to adopt the new technique, the lower cost of production, the lower price and the larger market share may render a higher profit rate. However, those factors force the rival capitalists to introduce the same machines, and once the adoption of the new technique becomes universal, the combined increase in investment costs results in a lower average rate of profit. Profitability falls, therefore, not because workers become less but rather more productive. This is Marx's "law of the tendency of the rate of profit to fall." (We shall refer to it as LFTRP.)

The dispute between these two crisis theories has some serious political implications. On the one hand, if the "profit-squeeze" argument provides the correct explanation of the problem, two interesting questions arise, namely: (1) will the lessening of class struggle, by government redistribution of income for instance, ensure economic stability in capitalism? (2) If so, when the economy goes into depression, should workers be held "responsible" for it? On the other hand, if the LFTRP provides the correct explanation, one must conclude that in capitalism economic crises are unavoidable: to survive, capitalism needs mechanization, and mechanization itself creates the condition for economic downturns.[2]

This is one of the most criticized theses in the history of political economy. Mark Blaug (1960) and Paul Sweezy (1981) claim that the LFTRP is flawed because it rests upon the premise that technical change is capital-biased,[3] whereas, in their opinion, the historical evidence does not suggest so.[4] Nobuo Okishio (1961) offers a further critique. Using a model from which fixed capital is absent, he concludes that the introduction of cost-reducing techniques is *incompatible* with a falling rate of profit.[5] Today most critics of Marx accept this result as a conclusive refutation of his LFTRP,[6] hence of his dictum regarding the inevitability of economic crises under capitalism. On the other hand, the LFTRP is one of the Marxian theses that many hold to be crucial to his system.[7] After all, it was Marx himself who once referred to it as "from the historical point of view, the most important law of modern political economy" (Marx, 1973:748.)

In my opinion, neither side in this dispute provides a correct evaluation of the LFTRP. Those arguments which favor the original formulation by Marx are either inaccurate or based on assumptions which seem to be unwarranted. Often they are also esoteric. On the other hand, the empirical objections to the LFTRP, such as those raised by Blaug (1960) and Sweezy (1981) shed little light on the issue. Finally, it appears that the Okishio theorem is only valid in the unrealistic world of an economy without fixed capital. Arguments which generally support the Okishio theorem (Persky and Alberro, 1979 , and

Roemer, 1979 and 1981) seem to rely (as already suggested by Shaikh, 1978b and 1982) on a false interpretation of two analytical categories used by Marx, namely the idea of *competition* and the concept of *prices of production*.

This calls for a detailed assessment of the LFTRP and we intend to carry it out in this dissertation. It will be shown that, from the theoretical point of view, no definite conclusion can be reached concerning the effects of mechanization upon the average rate of profit. This is counter to the existing positions on the issue. The latter will be analyzed and their defects clearly pointed out. It will also be shown that we can determine *the conditions* under which the LFTRP must hold. These conditions will be derived, and the likelihood of their occurrence will be examined. The expectation is that, accordingly, the LFTRP will be situated in its proper theoretical niche.

Methodology

In recent years Marxian political economy has incorporated the use of modern mathematical techniques, resulting in advantages and disadvantages. On the one hand, new theoretical insights are to be expected; on the other hand, there will be a loss in analytical simplicity. Hence, mathematical tools ought to be used only in so far as they allow us to obtain results which otherwise would be difficult, or impossible, to derive. Unfortunately, this principle is sometimes forgotten and mathematical esoterica take precedence over economic fundamentals.[8] We shall try to *avoid* such an approach. Even though obscurity has

come to play a major role in the distribution of intellectual respect among economists, our preference is for clarity. Hence, our main arguments will be conducted in terms of a simple model of the economy involving only two sectors: "consumer goods" (sector 1) and "capital goods" (sector 2.) The reason for this is simple: while the use of a more disaggregated model would complicate the arguments greatly, it would not at all increase their theoretical substance.

In addition to the above, our analysis will assume that the real wage remains constant. This assumption is necessary to ***isolate*** the effects of mechanization upon the rate of profit. Otherwise, we would not be able to determine whether the rate of profit behaves in a particular way due to mechanization alone or to changes in the real wage. In that case one of our fundamental goals, namely, to compare the LFTRP and the "profit-squeeze" arguments would be impossible. Thus, although the constancy of the real wage is neither a feature of reality nor a characteristic of the Marxian model as such, it becomes a necessary ***theoretical device*** in the analysis of the LFTRP.

Finally, it may prove useful to mention, although it will be clear by the context, that fixed capital is not introduced into our analysis until we reach Section IV, where it becomes essential to carry out the argument. Up to that point, nothing substantive is lost by avoiding the treatment of fixed capital.

Notes

[1]National income (Y) is distributed between profits (Π)

and wages (W): $Y=\Pi+W$. From this we have $\Pi/Y=1-W/Y$, where Π/Y is the relative share of profits and W/Y is the relative share of wages. On the other hand, the rate of profit is $\pi=\Pi/K$, where K is the capital stock. Dividing this expression by Y, we obtain $\pi=(1-W/Y)\div(K/Y)$. Since most empirical estimations suggest that K/Y (the capital-output ratio) does not exhibit a downward trend (see section III below), it follows that if the wage share (W/Y) increases the profit share (Π/Y) must decrease and so must the rate of profit. The "profit-squeeze" argument has a long history. It goes back to the French economist Frederic Bastiat in the 1840s and the American Henry Carey in the 1860s (see Marx, 1973:755.) In its modern form, it is best represented by Andrew Glyn and Bob Sutcliffe (1972) in Great Britain, and by Rafford Boddy and James Crotty (1975) in the United States.

[2]The thesis that in capitalism economic crises are unavoidable is Marx's alone. David Ricardo, for instance, also portrays the capitalist economy as inherently unstable, but in his model economic instability can be countered. In the Ricardian explanation, the rate of profit falls due to the existence of diminishing returns in agriculture:as population grows with the development of society, progressively less fertile land has to be brought into cultivation. Thus, an ever-increasing amount of capital must be used to produce each additional unit of output. There follows a fall in the rate of profit. Now, without the incentive to invest, capitals withdraw from the economy, and this leads to the ***stationary state*** (a situation where investment has ended.) But Ricardo was optimistic, asserting that the fall in the rate of profit could be avoided by the continual introduction of more efficient (i.e., cost-reducing) techniques of production. (For a detailed mathematical treatment of the Ricardian model see Pasinetti, 1959:78-92.) Marx, however, rejected the "law" of diminishing returns in agriculture and with it the entire Ricardian explanation of the stationary state. (The law of diminishing returns in agriculture was one of Marx's favorite targets for criticism. See Meek, 1953.) For Marx, it was precisely the introduction of cost-reducing techniques which caused the rate of profit to fall. Simply put, he turned the Ricardian explanation on its head.

[3]It is indeed true that the LFTRP rests in part on this assumption (See Section III below.)

[4]This criticism militates not simply against Marx but also against the entire theoretical tradition of the 19th century, including Taussig, J. B. Clark and Bohm-Bawerk, among others (see Gourvitch, 1940:93-95.) For an analysis of the historical evidence seemingly favorable to the point of view supported by Blaug and Sweezy, see Fellner (1956:246-47.) The same critique is also raised by Joan Robinson (1957), who modified her

opinion on the matter sometime between 1937 and 1956 (see her 1956:170, as opposed to her 1937:135.)

[5]It must be mentioned in passing that the Okishio theorem, albeit modern in its form, is quite old in its content. A similar claim to the one put forth by Okishio was made much earlier in Germany by von Bortkiewitz (1907a.) But his paper was not translated into English until 1952, and that was not the best time for Western scholars to investigate Marx. In Japan, however, Marxian economics has always found a more favorable environment (see Itoh, 1980:11-45.) Japanese discussions of the LFTRP within the framework suggested by Bortkiewitz were offered by Shibata (1934 and 1939.) Hence, it should not come as a surprise that the Okishio theorem was developed in Japan.

[6]Consider the following comments by Roemer (1981): "[The Okishio theorem] settles, in a fundamental way, the Marxian conjecture of a falling rate of profit due to competitive innovations... It is essentially the end of the classical story" (p.98); and "there seems to be no hope for the theory of the falling rate of profit within the strict confines of the environment that Marx suggested as relevant" (p.12.)

[7]The list of authors includes, among others, Paul Matick (1969), Samir Amin (1970 and 1975), David Yaffee (1973a and 1973b), Mario Cogoy (1974), Pierre Boccara (1974), Ernest Mandel (1975), Ben Fine and Richard Harris (1976 and 1979), Anwar Shaikh (1978a and 1978b), Manuel Castells (1980) and John Weeks (1981 and 1982.)

[8]This altogether wrong tendency to confuse relevance with obscurity has been noted by many and criticized by some (see, for instance, Samuelson, 1981:198; Baumol, 1984:7, and England (1986.)

§ I. THE MARXIAN MODEL

The LFTRP is deeply rooted in the Marxian theory of value and distribution and hence the understanding of that theory is prior to any discusion of the LFTRP. This section provides a critical assessment of the Marxian model as it is laid down in volumes one and three of *Capital* (see Marx, 1967.)

Following the classical tradition Marx defines the *value* of a commodity as "the labor-time socially necessary for its production" (vol.1:39.) In saying "labor-time socially necessary" he refers to that which is "required under the normal conditions of production, and with the average degree of skill and intensity prevalent at the time" (vol.1:39.). With this definition of value, Marx begins with the analysis of a society in which the direct producers of commodities are in possession of their respective means of production. Thus we have:

> A.1.1 (*Assumption 1 of vol.1*) : The direct producer of commodities owns the means of production and the the commodities produced with them.

In these conditions, the producer of a specific commodity brings to the market a portion of his output and exchanges it for other commodities which he also needs for his survival. The proportions in which the commodities are exchanged must coincide with those of the labor-time socially necessary to produce them; that is, if the labor-time necessary to produce one unit of commodity A is twice the labor-time necessary to produce one

unit of commodity B, then one unit of A will be exchanged for two units of B. It is easy to show that this must be so. Suppose that it were not. For example, let one unit of A be exchanged for one unit of B: in that case, nobody will produce A. This follows from the knowledge that with half the labor-time socially necessary to produce one unit of A, it is possible to produce one unit of B, which can then be exchanged in the market for one unit of A. In general, if the proportions of exchange do not coincide with those of the labor-time socially necessary to produce the commodities only one commodity will be produced, namely, the one which in the market offers the best proportion of exchange. (Which is absurd because if only one commodity is produced there can be no exchange nor, therefore, a market.)[1]

Now, it is obvious that it would be impossible to carry out all the necessary transaction if they were to be made by direct exchange of physical equivalents: one pound of meat for one of wheat, etc. To activate the process *money* has been "invented," and money is *any commodity* accepted as means of exchange by the transactors. Hence, the value of money is determined by the labor-time socially necessary for its production. Therefore, let us assume that gold is chosen as the *money commodity*, and that the labor-time socially necessary to produce one unit of it, say one ounce, is one hour. Also, assume that the production of one unit of wheat (say one pound) requires two hours to be produced. Hence, one pound of wheat will be exchanged for two ounces of gold, and this is called its *price*. Similarly, if the production of

one pound of meat requires one hour of socially necessary labor-time, one ounce of gold will be its price. Therefore, under the conditions established by A.1.1, the *value* and the *price* of a commodity coincide: the latter is merely the money equivalent of the former. Hence,

$$p_i=\lambda_i \text{ for all } i \ (i=1,\ldots,n),$$

where p_i represents the price, and λ_i the value, of commodity i (any one of the n commodities in the market.)[2]

Marx calls the situation described above, Simple Commodity Production. In it, production and exchange have the only end of satisfying social needs. The producer,

> starts with Commodities [C], turns them into Money [M], and thence once again into Commodities [C']. Commodities constitute the beginning and the end of the transaction which finds its rationale in the fact that the commodities adquired are qualitatively different from those given up. Marx designates this circuit symbolically as C-M-C' (Sweezy, 1942:57.)

Homogeneous Capitalism

Under capitalism, both the means of production and the commodities produced with them belong to the capitalist. The direct producer owns only his *labor-power*, that is to say, the potential capacity for laboring in the production of commodities during a period of time.[3] For Marx, labor-power is a commoty whose value "is determined, as in the case of every other commodity, by the labor-time necessary for [its] production" (Marx, 1967:1:171.) But the production of labor-power is only possible if the laborer consumes the necessary means of subsis-

tence to maintain himself in a normal state.[4] Therefore,

> the labor-time requisite for the production of labor-power reduces itself to that necessary for the production of those means of subsistence; in other words, the value of labor-power is the value of the means of subsistence necessary for the maintenance of the labourer (Marx, 1967:1:171.)

In such conditions the worker and the capitalist go to the market. In exchange for a sum of money (M), the latter adquires raw materials, machinery and labor-power (C) from which he derives, after a process of production is carried out in his factory, a new commodity (C'). Then he returns to the market with the new commodity and trades it for another sum of money (M'). Thus we have the circuit C-M→M'-C'. Here the rationale C-M-C' is absent because the capitalist starts with one commodity and ends with the same one: *money*. Why does he complete the circuit at all? Simply because the *amount* of money with which he ends the process (M') is greater than the amount advanced in its beginning (M). From the standpoint of the capitalist, production and exchange are meaningful only because they allow him to obtain a *profit*. But then, where does this profit come from? In order to answer this question Marx assumes that only equivalents in value are exchanged in the market. Hence no profit can be created in the process of exchange.[5] It follows that for M' to be greater than M the value of C' must be greater than the value C. In other words, the capitalist obtains a profit because the commodity that he sells (C') represents a higher value than the commodities that he buys (C). This means that it

is in the process of production (i.e., in the transformation of C into C') where profit is created. Now neither machines nor raw material possess "capacity for laboring," and hence they cannot contribute to the production of C' with a greater value than their own (a value which the capitalist has paid.) Thus Marx (1967:1: 209) writes:

> [Since] that part of capital (...) represented by the means of production, by the raw material, auxiliary material and the instruments of labour, does not, in in the process of production, undergo any quantitative alteration of value, I call it the constant part of capital, or more shortly, constant capital.

Only the labor-power remains to explain the difference of value between C and C'. Does labor-power add to output a value above its own? According to Marx, it does. The capitalist who buys labor-power pays its exact value. However, during the process of production he uses the labor-power (i.e., the laborer actually works) for a period of time which is longer than the necessary to reproduce its value (i.e., the value of the means of subsistence which, in the form of money, the capitalist pays to the worker.) Hence labor-power adds to the product an increment of value above its own, so Marx (1967:1:209) writes:

> That part of capital, represented by labour-power, does, in the process of production, undergo an alteration of value. It both reproduces its own value and also produces an excess, a surplus-value. I therefore call it the variable part of capital, or, shortly, variable capital.

The surplus-value explains, therefore, the difference of value between the commodities that the capitalist buys (C) and the commodity that he sells (C'), and this, in turn, explains the

difference between the sum of money that he advances (M) and the sum of money that he finally receives (M'). Therefore, profit is the money expression of surplus-value.

According to what has been said above, the value λ_i of a commodity i (i=1,...,n) can be represented as follows:

$$\lambda_i=c_i+v_i+s_i, \qquad [1]$$

where c_i is the constant capital, v_i the variable capital, and s_i the surplus-value embodied in one unit of the commodity. Let x_i be the total output (i.e, the # of units produced) of commodity i (i=1,...,n). Then its value is given by:

$$\Lambda_i=x_i\lambda_i=x_i(c_i+v_i+s_i)=x_ic_i+x_iv_i+x_is_i=C_i+V_i+S_i \qquad [2]$$

We have seen that the capitalist derives a profit from the use of labor-power. To put it in other words, the capitalist "exploits" the worker. The degree of exploitation is measured by the ***rate of surplus-value***, that is , the proportion between the labor-time that the capitalist does not pay and the labor-time which he does pay to the worker,

$$\epsilon_i=s_i/v_i \quad (i=1,...,n) \qquad [3]$$

For analytical purposes Marx assumes that labor is homogeneous (i.e., equally skillful) and mobile as between industries, and thus he makes ϵ is the same in all sectors of the economy, i.e.[6]

$$\epsilon_i=\epsilon \text{ for all } i \ (i=1,...,n) \qquad [4]$$

We have also seen that profit is the money form of surplus-

value. Thus, profit is the outcome of exploitation, and hence it flows from variable capital (*and only from it.*) However,

> So far as the individual capitalist is concerned, it is evident that he is only interested in the relation of the surplus-value, or the excess value at which he sells his commodities, to the total capital advanced for the production of the commodities, while the specific relationship and inner connection of this surplus with the various components of capital fail to interest him, and it is, morover, rather in his interest to draw the veil over this specific relationship and this intrinsic connection (Marx, 1967: 3:43.)

Hence he computes his profit Δ_i as a percentage ρ_i of the total investment. That is, $\Delta_i=\rho_i(C_i+V_i)$. That this profit comes only from the part of capital invested in labor-power, is not only a matter which does not concern the capitalist, but it is also one which he finds difficult to perceive. So long as without the constant part of capital, production cannot occur -nor, therefore, any profit be created- it is reasonable for him to assume that all the inputs contribute to the creation of profit.

Since $\Delta_i=\rho_i(C_i+V_i)$ and $\Delta_i=S_i$, we have

$$\rho_i=\frac{S_i}{(C_i+V_i)} \qquad (i=1,\ldots,n), \qquad [5]$$

which is the *rate of profit* in the production of the i-th commodity. (Since we implicitly assume a "one commodity-one capitalist" economy, r_i is the rate of profit for the i-th capitalist.) Using [3] and [4], expression [5] can be written as follows:

$$\rho_i=\frac{\epsilon V_i}{(C_i+V_i)}=\frac{\epsilon}{\dfrac{C_i}{V_i}+1}=\frac{\epsilon}{\Omega_i+1} \qquad [6]$$

where $\Omega_i=C_i/V_i$ is the ***organic composition of capital*** in the i-th industry ($i=1,\ldots,n$), and it measures the degree in which constant and variable capital participate in the total investment. Initially, Marx assumes that the organic composition is the same in every industry (hence the denomination ***homogeneous*** capitalism),[6] i.e. $\Omega_i=\Omega$ for all i ($i=1,\ldots,n$) Consequently,

$$\rho_i=\rho \text{ for all } i \ (i=1,\ldots,n).$$

This means that the rate of profit is uniform across the economy, and in that case the value λ_i and the price p_i of commodity i ($i=1,\ldots,n$) coincide. This is easy to show. By definition, the price of a commodity is the summation of the cost of production per unit of output (c_i+v_i) plus a percentage ρ (the rate of profit) of the total investment per unit. Since so far we are assuming that all capital is circulating (there is no fixed capital, i.e. the turnover period is unity), the investment cost per unit of output simply coincides with the cost of production per unit.[8] Hence,

$$p_i=(c_i+v_i)+\rho\,(c_i+v_i)=(1+\rho)\,(c_i+v_i) \qquad (i=1,\ldots,n) \qquad [7]$$

The value λ_i is given by expression [1], i.e.,

$$\lambda_i=c_i+v_i+s_i \qquad (i=1,\ldots,n.)$$

Dividing these two expressions, we obtain:

$$\frac{p_i}{\lambda_i}=\frac{1+\rho}{c_i+v_i}=\frac{1+\dfrac{s_i}{c_i+v_i}}{1+\dfrac{s_i}{c_i+v_i}}=\frac{1+\dfrac{s_i x_i}{c_i x_i+v_i x_i}}{1+\dfrac{s_i}{c_i+v_i}}=1 \Leftrightarrow p_i=\lambda_i,$$

for all i ($i=1,\ldots,n$.)

It follows from above that ***Homogeneous Capitalism*** can be summarized by the following model:

A.1'.1 (***Assumption 1' of vol.1***). The direct producers of commodities own neither the means of production nor the commodoties produced with them. They only own their labor-power.

A.2.1 (***Assumption 2 of vol.1***). (a) The rate of surplus-value is uniform across the economy: $\epsilon_i=\epsilon$ for all i ($i=1,\ldots,n$.) (b) The organic composition of capital is also uniform across the economy: $\Omega_i=\Omega$ for all i ($i=1,\ldots,n$.)

Under these circumstances,

(1) The rate of profit is uniform across the economy: $\rho_i=\rho$ for all i ($i=1,\ldots,n$.)

(2) Commodities are exchanged at their values: $p_i=\lambda_i$ for all i ($i=1,\ldots,n$.)

(3) The profit obtained by each individual capitalist is the amount of surplus-value generated in his own industry. Thus, profit is simply the money-form of surplus-value.

Heterogeneous Capitalism

One of the assumptions of the previous model does not hold in capitalism as we know it today. That assumption is A.2.1(b), for it is evident that the organic composition is not the same in every industry. What would happen to the economic 'order' des-

cribed by the model if we let the organic composition vary from one sector to another?[9] We introduce the following assumption:

A.1.3 (*Assumption 1 of vol.3*) $\Omega_i \neq \Omega$ for some i (i=1,..,n)

Under this assumption we have (see expression [6] above) $\rho_i=\rho$ in general. It follows that capitals of the same magnitude, but of different Ω_i's, will yield different amounts of profit. Marx explains the reason for this, as follows:

> Capitals of the same magnitude operating for the same working-time and with the same degree of exploitation may produce very much different amounts of profit, because of surplus-value, for the reason that a difference in the organic composition of capital in different spheres of production implies a difference in their variable part (...), and therefore also a difference in the quantities of surplus-labor appropriated by them (Marx, 1967:3:149.) Accordingly, the rates of profit prevailing in the various branches of production are *originally* very different (Marx, 1967:3:158. Emphasis added.)

Now while this situation is possible transitorily, in the long run it cannot be maintained "without abolishing the entire system of capitalist production" (Marx, 1967:3:153.) For it is evident that under the logic of capitalism no investor will be satisfied with a return smaller than the one obtained with the same capital somewhere else in the economy. Over the long-period, competition will move the different rates of profit toward some uniform level σ. The long run profit of the i-th capitalist can thus be expressed by

$$\Delta_i = \sigma (C_i+V_i) \qquad (i=1,\ldots,n) \qquad [7]$$

Since $\Sigma\Delta_i=S$, where S is the total surplus-value generated in

the economy, we have $\Sigma\Delta_i=\sigma\Sigma(C_i+V_i)=\sigma(C+V)$, where C and V represent, respectively, the total constant capital and the total variable capital invested in the economy. It follows that the uniform (Marx calls it *general*) rate of profit is given by

$$\sigma=\frac{S}{C+V} \qquad [8]$$

Substitution of this expression into [7] leads to

$$\Delta_i=\frac{S}{C+V}(C_i+V_i)=\frac{\epsilon V}{C+V}(C_i+V_i)=\frac{\epsilon}{\frac{C}{V}+1}(C_i+V_i)=$$

$$=\frac{\frac{S_i}{V_i}(C_i+V_i)}{\frac{C}{V}+1}=\frac{\frac{C_i}{V_i}+1}{\frac{C}{V}+1}S_i=\frac{\Omega_i+1}{\Omega+1}S_i \qquad [9]$$

where $\Omega=C/V$ is the *social* or *average* organic composition of capital. If for some i ($i=1,\ldots,n$) $\Omega_i=\Omega$, then in that industry it is $\Delta_i=S_i$. But this can only happen by chance since in general it is $\Omega_i\neq\Omega$ by A.1.3. Thus the profit of the i-th capitalist ($i=1, 2,\ldots,n$) does not —in general— coincide with the surplus-value generated in his own industry. What, then, is the profit of each individual capitalist? In order to answer this question, let us rewrite expression [9] as follows:

$$\frac{\Delta_i}{C_i+V_i}=\frac{S}{C+V} \qquad (i=1,\ldots,n)$$

that is,

$$\frac{\Delta_1}{C_1+V_1}=\frac{\Delta_2}{C_2+V_2}=\cdots\cdots=\frac{\Delta_n}{C_n+V_n}=\frac{S}{C+V}$$

These equalities tell us that each individual capitalist receives as profit the corresponding share of the total surplus-value when this is distributed among all capitalists in proportion to each one's individual investments. In other words,

> So far as profits are concerned, the various capitalists are just so many stockholders in a stock company in which the shares of profit are uniformly divided per 100, so that profits differ in the case of the individual capitalists only in accordance with the amount of capital invested by each in the aggregate enterprise, i.e., according to his investment in social production as a whole, according to the number of his shares (Marx, 1967:3:158.)

This is how Marx conceives of the distribution of total surplus. As Professor Baumol (1974:51-52) puts it,

> The substance of Marx's analysis [of this issue] can be summarized in a simple parable, in which the economy is described as an aggregation of industries each of which contributes [with its surplus-value] to a storehouse containing the total surplus.

The distribution of this social surplus from the "central storehouse" is such that

> the capitalists of the various spheres of production (...) do not secure the surplus-value (...) created in their own sphere (...) What they secure is only as much surplus-value (...) as falls, when uniformly distributed, to the share of every aliquot part of the

> total social capital from the total social surplus-value (...) produced in a given time by the social capital in all spheres of production. Every 100 of an invested capital, whatever its composition, draws as much profit in a year, or any other period of time, as falls to the share of every 100 (...) during the same period (Marx, 1967:3:158.)

Going back to expression [9] we can find the rationale behind this. Notice that $\Delta_1 > S_1$ when $\Omega_1 > \Omega$, and $\Delta_1 < S_1$ when $\Omega_1 < \Omega$. What happens is that in the competitive process that leads to the formation of the general rate of profit, a transfer of surplus-value takes place from the low to the high organic composition sectors. In other words, ***capital-intensive*** investments draw ***more***, and ***labor-intensive*** investments draw less, surplus-value than they themselves generate. Hence, there is a great incentive for capitalists to mechanize their industries.[10]

It has been shown above that the uniform, long-period rate of profit is $\sigma = S/(C+V)$. On the basis of this rate of profit we can define long-period prices in the usual manner, i.e.

$$p_1 = (c_1+v_1) + \sigma (c_1+v_1) = (1+\sigma)(c_1+v_1) \qquad [10]$$

These prices are in the long run "a prerequisite of supply, of the reproduction of commodities" (Marx, 1967:3:198.), and so Marx calls them ***prices of production***. They are the "centers of gravity" of market prices, i.e the level around which market prices fluctuate according to random (***short run***) changes of supply and demand .[11]

It is to be noticed that the prices of production ***do not*** coincide with their corresponding values. This is easy to show.

Dividing [10] by [1] we have:

$$\frac{p_1}{\lambda_1}=\frac{1+\epsilon\dfrac{V}{C+V}}{1+\epsilon\dfrac{v_1}{c_1+v_1}}=\frac{1+\dfrac{\epsilon}{\Omega+1}}{1+\dfrac{\epsilon}{\Omega_1+1}},$$

where $p_1=\lambda_1$ only if : (1) $\epsilon=0$, that is, if there is no exploitation and hence no profit (which is impossible for every capitalist because it denies the very foundation of capitalism), or (2) $\Omega_1=\Omega$, which may be possible for some industries but not for all, since $\Omega_1\neq\Omega$ for some i (i=1,..,n) by assumption. Hence, in general value and price do not coincide. If $\Omega_1>\Omega$, then $p_1>\lambda_1$, and if $\Omega_1<\Omega$, then $p_1<\lambda_1$.[12]

The Marxian Method

Some scholars (notably Morishima and Catephores, 1978) have suggested that the three situations discussed above (namely, Simple Commodity Production, Homogeneous Capitalism and Heterogeneous Capitalism) are simple abstract models of capitalism. In other words, those three analytical stages are interpreted as mere ***theoretical devices*** to explain a complex reality (*capitalism.*) First, a simple model is constructed (Simple Commodity Production), and then, by relaxing some assumptions, we move progressively to the concrete object of our study (Heterogeneous Capitalism.) These scholars see Marx under the light of their own *positivist* orthodoxy.

That *is not* the Marxian method. If it were, nothing would distinguish it from that of the neoclassical school, whereas the main difference between the two approaches to political economy is essentially methodological. Neoclassical economists study capitalism without ever questioning where it comes from and where it is leading to. This issue does not even make sense to them, probably because they are convinced that capitalism does not move at all. In addition to this, they take capitalism for what it appears to be in its "surface." That is to say, given that the *exchange* of commodities is the ultimate manifestation of capitalism, given that exchange has to do with *prices* and *profits*, and given that economic agents relate through exchanges, the neoclassicals conclude that the analysis of capitalism must be done at that level.

Marx saw things in a different way. On the one hand, he grew up as a young Hegelian, and this predisposed him to consider that nothing is immutable. Quite the contrary, for him everything is a consequence of past realities and is constantly changing. Thus, the present capitalist system is the result of changes that took place in a previous system of production, which, in turn, was the result of the changes occurred in a previous system, and so on. For Marx, the laws governing today's production, exchange and distribution are not the same as in previous times, and in order to know today's laws and their future development we must analyze yesterday's laws and investigate how they evolved. On the other hand, Marx never be-

lieved that it was possible to analyze capitalism (or anything else) by focussing only on the kind of phenomena through which it becomes visible (*commodity exchange*.) In his view, "if the essence of things directly coincided with their phenomenal forms, all science would be superfluous." For him, exchange, and therefore prices and profits, are the "phenomenal forms" that hide the true nature of capitalism. On the surface of the system we have *exchange*, where everyone trades his commodities freely. This applies not only to transactions among capitalists, but also between capitalists and workers. The worker who sells his labor-power to a capitalist does so voluntarily, i.e., he is not *legally coerced* into doing it. Thus, by focussing exclusively on exchange, capitalism appears as a social system based on *egalitarian relations*. However, behind exchange we have *production*, where capitalism shows a different face: one of *exploitation* of one human being (the *worker*) by another (the *capitalist*.) Behind the "*visible*" world of egalitarian exchange (with prices and profits), there is the "*invisible*" world of exploitative production (with values and surplus-value.) Marx's theoretical endeavour tries to bring the two aforementioned claims to light, namely: (1) that capitalism is indeed moving under certain laws of its own, and (2) that one of those laws is its dependency on the "exploitation" of labor.

In his analysis Marx starts from a situation in which the direct producers of commodities own the means of production and the final products. It is also assumed (implicitly) that the

organic composition of capital is the same throughout the economy. Under these circumstances there is no profit attached to the production and exchange of commodities other than the satisfaction of social needs, and prices are the money equivalent of values. Marx calls this situation *Simple Commodity Production*, and it is not "fiction" or "scientific hypothesis"; nor is it a mere "abstraction of capitalism," but the theoretical counterpart of a concrete historical reality by which it was preceded, that in which

> the labourer owns his means of production, and this is the condition of the land-owning farmer living off his own labour and the craftsman, in the ancient as well as in the modern world (Marx, 1967:3:177.)

This situation started to change with the first symptoms of capitalism, when the ownership of the means of production shifted gradually from the direct producers to the hands of a few individuals. The form in which this took place is not identical everywhere, but it has some basic features which are common to every country. In particular, direct coercion, market expansion and the subsequent development of a monetary economy appear to be the basis of the process through which the direct producers lost ownership of their means of production. The increasing importance of commerce made feudal landlords require money rather than in-kind contributions from their peasants. Thus, in order to raise the money required to pay their rents, the latter became increasingly dependent on the merchant clients who bought their crops at increasingly

low prices. That was the moment in which the best situated peasants as well as the merchants became richer by exploiting their neighbors through money loans and the purchase of land, cattle, etc. at unusually low costs. Landless and moneyless, the majority of the peasants had to emigrate to the cities or to become hired workers in their villages.

The artisans in the cities were deprived of their workshops in a similar manner. They owned the means of production, but not the raw materials; these were controlled by the merchants. In the beginning, the merchant was a simple intermediary in the *exchange* of commodities between the cities and the country side, but he soon began to have a say in the organization of *production*. Provided that the artisans sold their products to him at low prices, he was willing to advance money and raw materials to them. In this way many craftsmen eventually fell into his hands. After becoming the owner of the workshops, the merchant hired the old owners as simple workers. Being still a merchant, he also began to be a capitalist. "What could induce [him] to take on [this] extra business?. Only one thing: the prospect of greater profit at the same selling price as the others. And he had this prospect" (Engels, 1967:904-5.): By taking the little master into his service, the merchant capitalist was in fact buying labor-power and appropriating surplus-value. Under the pressure of an implacable competition, those artisans who did not submit to the merchants' rule had to become capitalists themselves. They did so by employ-

ing as workers those peasants who "landless and moneyless" were trying to make a living in the cities.

Basically, this is the process through which the class of "free workers" was formed. Gathered in the capitalist workshop, artisans and peasants were all, at the beginning, engaged in a uniform type of production. It soon became clear, however, that production could be greatly improved by the division of labor. In this way manufacturing began to flourish. Slowly, the capitalist form of production put off the remains of the old system. The ownership of the means of production is already in the hands of the capitalists; labor-power has become a commodity —and as such is sold and bought in the market, and production has acquired a purpose beyond the mere satisfaction of social needs —the creation of profit... This is already capitalism, but with a distinguishing feature, namely, that the *technical base of production* can still be considered as *uniform.* In those circumstances value and price coincide, the latter being the money equivalent of the former. It also happens that in each sector of the economy a mass of value above the value of the inputs consumed in production is created owing to the use of labor-power. The *surplus-value* is formed in production, but it only becomes visible in the process of exchange under the mystified form of *profit.* Hence, there is no other source of profit besides the surplus-value. What makes this initial stage of capitalism peculiar, is the fact that each capitalist retains in the the form of profit so much surplus-value as is generated

in his own industry. This is the situation described by the our model of *Homogeneous Capitalism*. Therefore, this is neither a "scientific hypothesis" nor an abstraction of capitalism "in general." Quite the contrary, it is the theoretical counterpart of a *historically determined* period of capitalism —that which corresponds to its origin and first years of development, when the technical base still has not undergone important changes and may be considered the same across the economy.

The industrial revolution completely transformed this situation. Neither the expanding demand for industrial goods, nor the capitalist drive for profit, could be satisfied with the technical base of the initial stages of capitalism. There was the need for a change and this came with the introduction of *machinery*, first in England in the 18th century, and then in other European countries and the U.S.A. in the 19th century. However, mechanization did not take place uniformly. While the textile industries introduced machinery on a large scale rather early, "steel and other heavy industries and mining lagged behind" (see Jürgen Kuczinsky, 1972:238), so that the transition to mechanized production put and end to the uniformity of the technical base. This gave rise to a new stage in the development of capitalism which is characterized by the unequal composition of capitals in the various sectors of the economy, and which Marx analyzes in the third volume of *Capital*. This is the situation described by the model of *Heterogeneous Capitalism* which, therefore, is not an abstraction of capitalism "in general" but of that period of it

which began with the First Industrial Revolution. From this analysis Marx concluded that the diversification of the organic compositions originated fundamental changes in the operation of capitalism. On the one hand, the diversity of organic compositions gives rise to a variety of rates of profit whose equalization to a uniform rate requires that long run (*average*) prices deviate from the values of the corresponding commodities.[13] On the other hand, the profit obtained by each individual capitalist is not determined in the same way as before. What happens now is that the competition among capitalists to place their investments in the more mechanized sectors of the economy creates a transfer of surplus-value between industries. It is this transfer of surplus-value which *levels out* the different rates of profit and ensures a uniform rate for the whole economy. The individual capitalist no longer retains as profit the entire mass of surplus-value generated in his own industry, as it happened when capitalism was "homogeneous." Nevertheless it remains true —according to Marx— that the exploitation of labor is the only source of surplus-value and this is appropriated exclusively by the capitalists. This result is valid, therefore, for every period in the history of capitalism.

The "Great Contradiction"

Marx considered that the deviation of prices of production from the values of the corresponding commodities was only a logical result of the equalization of the rates of profit —and by

no means a theoretical flaw in his model. Nevertheless his opinion has been questioned very often. As early as 1895 —that is *one* year after the publication of the third volume of *Capital*— the Italian economist Achile Loria stated that Marx's theory of value was inconsistent, and a year later Böhm-Bawerk (1896) made a similar claim. They both maintained that volumes one and three of *Capital* contained two contrdicting theories: the *labor theory of value* (vol.1) and the *theory of prices of production* (vol.3.)

Böhm-Bawerk's criticism is based on strictly neoclassical grounds. What must economic science explain? The rates of exchange among commodities, i.e. their relative prices. How must this explanation be carried out? By analyzing exchange as it is found in typical, concrete market situations. We now know that Marx's opinion on this matter was very different, but —as Sweezy (1945:v-xxx) points out— Böhm-Bawerk pays no attention to it. He was convinced that the problems concerning him and his colleagues were *the problems* which economic science ought to resolve, so he attributed to Marx the same purposes. Now from where must the analysis begin? For Böhm-Bawerk the answer was very simple: Given that the exchange of commodities involves their *comparison* it must be based on something common to all commodities. According to Marx this "something common" is *labor*. Therefore, commodities should be exchanged according to the quantity of labor incorporated in each. Böhm-Bawerk replies that only commodities which are the product of

human effort contain labor. Natural goods such as water, land, etc. do not contain any labor. Therefore, labor *is not* the common element to all commodities, and hence it cannot serve as the basis for their comparison. Now if labor is not the common element we are looking for, *what is* that element? According to Böhm-Bawerk it is the ***utility*** that consumers derive from the goods. Goods have the property of satisfying human needs, and we assign value to things according to the utility that *we extract* from them. Hence the ***value*** of a commodity is the monetary expression of the ***utility*** that human beings ***attach*** to that particular commodity. For Böhm-Bawerk, Marx's crucial error was his failure to understand this phenomenon —a mistake which annuls any subsequent argumentation. As Sweezy (1945: xiii) puts it, "it was like a problem in arithmetic: if you find an error in the first line, you know that the answer must be wrong and that any calculations are worthless." He went on, however, and tried to prove that ***even within its own assumptions***, Marx's analysis of value was inconsistent. In doing this, Böhm-Bawerk proceeds as follows. Given that most commodities do require human labor, let us take for granted that labor is the yardstick of value. In *vol I* of *Capital*, Marx states that prices are equivalent to values. Therefore, value proportion coincide with the proportions of exchange, i.e. $\lambda_i/\lambda_j=p_i/p_j(=Q_j/Q_i)$, whre i and j are any two commodities and Q_i, Q_j represent the quantities exchanged of them. In this case Marx's model, including his theory of surplus-value, is entirely consistent.

However, in *vol.3* Marx states that values and prices do not coincide. Thus $\lambda_i/\lambda_j \neq p_i/p_j (=Q_j/Q_i)$, and hence the proportions of exchange cannot be explained by the labor time expended in the production of the corresponding commodities. There might seem to be a way in which, despite the difference between values and prices, value proportions can explain the proportions of exchange. This is so when $p_i=\alpha\lambda_i$ for all i $(i=1,\ldots,n)$; that is, the prices of all commodities deviate from their corresponding values by a constant factor of proportionality, $\alpha>0$. However, within the confines of the Marxian model this possibility has to be excluded because $p_i=\alpha\lambda_i \Leftrightarrow (1+\sigma)(c_i+v_i)=\alpha(c_i+v_i+s_i)$, from which we obtain

$$\alpha=\frac{(1+\sigma)(c_i+v_i)}{c_i+v_i+s_i}=\frac{1+\sigma}{1+\dfrac{s_i}{c_i+v_i}}=\frac{1+\sigma}{1+\dfrac{\epsilon}{\Omega_i+1}},$$

and since Ω_i is not uniform, α cannot be uniform either. From this, Böhm-Bawerk concludes that Marx's theory of value is a complete failure. Moreover, since his theory of exploitation depends entirely on his theory of value, that theory, too, falls to the ground. This is how Böhm-Bawerk reaches the following conclusion: *vol.1* of *Capital* contains a theory which explains relative prices as well as the origin and nature of capitalist profit; however, that theory depends on a very restrictive assumption: the equivalence of prices and values, or else, the equality of the

organic compositions of capital. Once this assumption is removed —as it is done in *vol.3*— the entire theoretical structure of *Capital* falls down.

A few years before Böhm-Bawerk criticized Marx, Philip Wicksteed had shown, based on Jevon's utility theory, that relative prices could be explained by the ratios of the *marginal utilities* which consumers derive from commodities. Almost at the same time, Wicksteed himself and J.B. Clark had developed, independently, the so called *Product Exhaustion Theorem*, according to which in the long run competitive equilibrium, rewarding each input with its marginal product precisely exhausts total output. This they interpreted as a proof that over the long period the exploitation of labor is impossible. As J.B. Clark (1891) put it, "What every class gets is, under natural law, what it contributes to the general output of industry" —thus no one is exploited. Therefore, when Böhm-Bawerk wrote his critique of Marx he was able to offer an alternative theory of value and distribution.

Why was it Böhm-Bawerk and not any other among the many neoclassical economists of the time, who criticized Marx? This has an explanation. As Sweezy (1945:viii-ix) mentions,

> Organized socialism in Europe experienced a rapid growth in the last three decades of the nineteenth century, and it was during this period that within the continental Socialism movement Marxism won out over rival schools and doctrines. Hence, while the original reaction of the academic world had been to ignore Marx, it became increasingly difficult to maintain this attitute; as time went on it became more and more urgent to organize a counter attack.

and Böhm-Bawerk was in the best position to do it. A member of the Austrian school,

> [he] was from the first a champion of the new marginal utility theory. His two major works, *Capital and Interest* and *The Positive Theory of Capital*, were published in 1884 and 1889 respectively, before he was forty years old; and as the subjective theory of value spread geographically and gained in popularity, Bohm-Bawerk's fame grew by leaps and bounds. By the turn of the century it is probable that his international reputation was greater than that of any other living economist (Sweezy, 1945:viii.)

In those conditions it was only natural that he led the orthodox argumentation in a very *militant* controversy with Marxism.[14] His critique of Marx soon became famous and in the neoclassical camp it was considered to be a definite blow to the Marxian system. In such conditions it is not surprising that its English translation, which appeared two years after the original German edition, carried the pretentious title of *Karl Marx and the Close of His System* —which, as Sweezy (1945:vi) notes, "sounds like an obituary for Marx and his theories."

That Bohm-Bawerk had not been fair to Marx was made clear by Rudolf Hilferding (1904). In one of his introductory paragraphs Hilferding says, referring to Böhm-Bawerk:

> Since his criticism deals with principles, since he does not attack isolated and arbitrarily selected points or conclusions, but questions and reflects as untenable the very foundation of the Marxian system, possibility is offered for a fruitful discussion (p.122)

Hilferding starts by pointing out that for Marx the goal of the economic analysis of a social order is to discover its *laws of motion*. In this light his theory of value is a means to deter-

mine the inner processes of capitalist society rather than a way to ascertain relative prices. In Marx's view, human society is articulated around *labor*, the element whose change in quality and quantity, organization and productive energy, determines in the final analysis the development of social life. It is for this reason that Marx, by taking the *socially necessary labor* as the starting point, is able to discover society's fundamental laws of motion. This way economics emerges as a social and historical science.

Once economic science is thus understood, the objective is to analyze the social relationships in which human beings become involved through the labor process. For such a purpose the study of market phenomena provides little help, if any at all. In so far as some social relationships whose analysis is crucial for the understanding of capitalism are established within the sphere of production, little will be gained by focussing on the realm of exchange. Likewise, the degree of subjective utility that individuals attach to commodities has no analytical power. Any theory which starts from that category,

> Starts from the individual relationship between a thing and a human being instead of starting from the social relationships of human beings one with another. This envolves the error of attempting from the subjective individual relationship, to deduce an objective social measure. Inasmuch as this individual relationship is equally present in all social conditions, inasmuch as it does not contain within itself any principle of change, we must, if we adopt such a procedure, renounce the hope of discovering the laws of motion and the evolutionary tendencies of society. Such an outlook is unhistorical and unsocial. Its categories are natural and eternal categories (Hilfer-

ding, 1904. For the English translation, p.122.)

Having made these general remarks, Hilferding moves on to analyze Böhm-Bawerk's opinion that there is a fundamental contradiction between the first and third volumes of *Capital*. What relationship is there between those two volumes? According to *vol.1* commodities are exchanged in proportion to their values, whereas according to *vol.3* they are not. "Who denies it?," says Hilferding. That happens because, as the ***historical conditions*** change, there occurs some modifications in exchange. The question is whether the law of value still works under the new conditions. In other words, are the new relations of exchange regulated by the quantity of labor incorporated in each commodity?

> If so, the law of value, though in modified form, continues to control exchange and the course of prices. All that it is necessary is that we should understand the course of prices to be a modification of the pre-existing course of prices, which was under direct control of the law of value (Hilferding, 1904. For the English translation, p.156.)

In Hilferding's opinion the question posed above has an afirmative answer because although prices and values do not coincide, the former are ***determined*** by the latter, i.e. $p_i=\alpha_i\lambda_i$ for all i ($i=1,\ldots,n$; and $\alpha_i \epsilon R^+$) —so that ***values and not prices*** regulate the proportion of exchange. In addition, it remains true that ***total value=total price*** and ***total surplus-value=total profit***, and this proves that profits are the outcome of exploitation and that the rate of profit is the same whether it is computed in value or in price terms. This follows directly from expressions [10] and [7]. From [10] we have

$$P_i=p_ix_i=[(1+\sigma)(c_i+v_i)]x_i=(1+\sigma)(C_i+V_i) \qquad (i=1,\ldots,n), \quad [11]$$

expression which gives the price measure of the total output of sector i (i=1,...,n). Hence, the price measure of the total output of the economy is given by

$$\Sigma P_i=(1+\sigma)\Sigma(C_i+V_i)=\left(1+\frac{S}{C+V}\right)(C+V)=C+V+S=\Sigma\Lambda_i, \quad [12]$$

and thus *total price=total value*. From expression [7] we have

$$\Sigma\Delta_i=\sigma\Sigma(C_i+V_i)=\frac{S}{C+V}(C+V)=S, \quad [13]$$

which shows that *total profit=total surplus-value*. Together the last two expressions imply that $(C+V)=(C+V)^p$, i.e., the total investment is the same whether measured in value or in price terms, and therefore,

$$\sigma=\frac{S}{C+V}=\frac{\Sigma\Delta_i}{(C+V)^p}, \quad [14]$$

i.e., the rate of profit is the same in value and in price terms.

In this form Hilferding concludes that there is no contradition between the first and third volumes of *Capital*. Inasmuch as they analyze different historical situations, they portray different conditions of exchange. In his view, if Böhm-Bawerk had understood Marx's method he would not have had any difficulty to discover the link between those two situations. As he did not, the explanation that he found for the deviation of prices from

values in *vol.3*, was to assume Marx's "withdrawal" from the theory developed in *vol.1*. In this regard Hilferding (1904) makes the following comment:

> To speak of a withdrawal in this connection is tantamount to saying that Marx, in order to remain at a definite point, first moved a mile forward and then a mile backward. Such is, nevertheless, the view which the vulgar economists have formed of the dialectic method, because they never see the process but only the completed result, so that the method always seems to them a mystical "hocus-pocus." (p. 155 for the English translation.)

The Transformation Problem

With Hilferding's reply to Böhm-Bawerk, the controversy between Marxists and neoclassicals seemed to have been resolved in favor of the former. Nevertheless the thesis that the price of production reflects the quantity of labor expended in the production of the corresponding commodity had not been proved at all. Hilferding might have scored one or two points against Böhm-Bawerk's own theory —as Joan Robinson once put it, but in no way did he show that prices are a transformation of values. Undoubtedly, Hilferding's argument relied on the presumption that expression [10] provides the correct formulation of prices —for in that case it is obvious that prices are a transformation of values. In truth, however, such a formulation of prices is incorrect, because it implies that inputs are bought at their values whereas outputs are sold at their prices —which is impossible because in the market what is an output for the seller is an input for the buyer. It is rather surprising that nei-

ther Hilferding nor Böhm-Bawerk ever realized this fact, more so since Marx himself was well aware of the problem:

> The foregoing statements have at any rate modified the original assumption concerning the determination of of the cost-price of commodities. We had originally assumed that the cost-price of a commodity equalled the *value* of the commodities consumed in its production. But for the buyer the price of production of a specific commodity is its cost-price, and may thus pass as cost-price into the prices of other commodities. Since the price of production may differ from the value of a commodity, it follows that the cost-price of a commodity containing this price of production of another commodity may also stand above or below that portion of its total value derived from the value of the means of production consumed by it. It is necessary to remember this modified significance of the cost-price, and to bear in mind that there is always the possibility of an error if the cost-price of a commodity in any particular sphere is identified with the value of the means of production consumed by it (Marx, 1967:3:164-65.)

In other words, Marx is saying that a correct formulation of prices must count *both* inputs and outputs in the same units, i.e. in price terms. Nevertheless, after making the above statement Marx left the matter behind by simply saying that "our present analysis does not necessitate a closer examination of this point" (Marx, 1967:3:165.) Now this opinion convinced almost no one because the problem was more serious than Marx thought. Once prices are correctly defined, what reason is there to believe that they are mere transformations of the corresponding values and —more importantly— that profit is the reflection of surplus-value? Without clarifying this issue, one fundamental purpose of *Capital*, namely, to show that exchange categories (equality, prices and profits) are but the phenomenal forms of pro-

duction categories (exploitation, values and surplus-value), is called into question. As soon as von Bortkiewitz (1907) pulled the alarm, an important number of scholars began to wonder whether the validity of the entire Marxian edifice depended on the solution of this problem. Ever since, the issue has been known as the *Transformation of Values into Prices of Production*, and it was the merit of von Bortkiewitz (1907b) to offer the first consistent solution. (Many others were provided afterwords,[15] but they are simple reformulations of von Bortkiewitz's treatment of the problem.)

For simplicity, let us assume that there are only two sectors in the economy, namely: *consumer goods* (sector 1) and *capital goods* (sector 2.) For this economy we define

p_i The price of production of commodity i (i=1, 2)
a_{zi} The capital goods input per unit of output of i (i=1, 2)
l_i The *direct* labor-time input per unit of i (i=1, 2)
ω The real wage rate (per hour of direct labor)
π The rate of profit (in price terms.)

Prices of production may thus be formulated as follows:

$$\left.\begin{aligned} p_1 &= (a_{z1}p_2+\omega l_1 p_1)(1+\pi) \\ p_2 &= (a_{z2}p_2+\omega l_2 p_1)(1+\pi) \end{aligned}\right\} \qquad [15.a], [15.b],$$

and letting $p_i=\alpha_i\lambda_i$ (i=1, 2) we have

$$\left.\begin{aligned} \alpha_1\lambda_1 &= (a_{z1}\alpha_2\lambda_2+\omega l_1\alpha_1\lambda_1)(1+\pi) \\ \alpha_2\lambda_2 &= (a_{z2}\alpha_2\lambda_2+\omega l_2\alpha_1\lambda_1)(1+\pi) \end{aligned}\right\} \qquad [16.a], [16.b],$$

that is,

$$\left.\begin{aligned}\alpha_1&=\left(a_{21}(\lambda_2/\lambda_1)\,\alpha_2+\omega l_1\alpha_1\right)(1+\pi)\\ \alpha_2&=\left(a_{22}\alpha_2+\omega l_2(\lambda_1/\lambda_2)\,\alpha_1\right)(1+\pi)\end{aligned}\right\}\quad [17.a],[17.b].$$

This system has two equations and three unknowns (the two α's and π.) Therefore one more equation must be added in order for it to be solvable. When this is done the system has a unique solution $\{\alpha_1, \alpha_2, \pi\}$, which proves that prices of production can indeed be expressed as transformations of the corresponding values. The only problem is to decide which equation, specifically, is to be added in the modal. In this regard, there are several alternatives, among them [12] *or* [13] —*but not both.* This raises a problem: if we choose [12], then, in general, [13] will not hold.[16] Alternatively, if we choose [13], it will be [12] which does not hold. In any case, [14] is no longer true, i.e. the rate of profit is not the same in value and in price terms. This is easy to prove. Suppose that we choose [12], so that $\Sigma P_1=\Sigma\Lambda_1$ and $\Sigma\Delta_1\neq S$. Obviously $\Sigma P_1=\Sigma\lambda_1 \Leftrightarrow (C+V)^p+\Sigma\Delta_1=(C+V)+S$ and since $\Sigma\Delta_1\neq S$ we have $(C+V)^p\neq C+V$, and hence [14] is not true. Now suppose that we choose [13], so that $\Sigma\Delta_1=S$ and $\Sigma P_1\neq\Sigma\Lambda_1$. This also implies that $(C+V)^p\neq C+V$, hence [14] does not hold.

So Which Rate of Profit?

We now come to a last issue: since the value and the price rates of profit are not the same, the question may arise as to which one we should use for the analysis of the LFTRP. Some critics have suggested that since the economic agents operate in

price terms, the price rate of profit should be the relevant one (see Steedman, 1977:30.) Nevertheless this is hardly a reason to dismiss the value rate of profit. For if one accepts the notion of "essence" vs. "appearance" in capitalism, one must also admit that it is *the former*, and not the latter, which is of import. In any case, for our present purpose we will not have to make a choice. This is so because although the value and the price rates of profit do not coincide, they *move in the same direction* (see Shaikh, 1982:75; and, in relation with the LFTRP, Roemer, 1981:97.) So far as we are concerned, we may use either the value system or the price system. For it would not matter *where* we found *what*: if mechanization raises (lowers) one of the two aforementioned rates of profit, it must also raise (lower) the other. Therefore, the existing LFTRP arguments can be analyzed, and new ones may be constructed, either in terms of the value system or in terms of the price system. In what follows, we will use this prerogative to our convenience.

Section Notes

[1]This analysis assumes that each individual worker (producer) commercializes his or her own outputs, and that every worker is capable of producing any commodity —this implies that the remuneration per hour of labor is the same in all economic activities.

[2]That under Simple Commodity Production price and value must coincide may also be shown using Piero Sraffa's "algorithm of dated labor" (see Appendix I below.)

[3]"By labor-power or capacity for labour it is to be understood the aggregate of those mental and physical capabilities

existing in a human being, which he exercices whenever he produces [commodities] of any description" (Marx, 1967:1:171.)

[4]The term "means of subsistence" has a very ample meaning: it refers to the volume of the so-called "natural wants" (food, clouthing, housing, etc.), "which vary according to the climatic and other physical conditions" of each country, but basically and above all, according to the "habits and degree of comfort [in which the working class] has been formed...Nevertheless, in a given country, and at a given period, the average quantity of the means of subsistence necessary for the laborer is practically known " (Marx, 1967:1:171.)

[5]Marx does not deny the possibility of fraud in the exchange of commodities. What he denies is that profit can be explained in that way. Why? Let us assume that some transactions are not made according to equivalents. In that case, what is a profit for one transactor is a loss for another, and profits and losses cancel each other out. This implies that in the aggregate there can be no surplus (net profit), which means that the economy can *never* grow. This is absurd.

[6]Morishima (1973:180-81) makes a rather curious criticism of this assumption. In his view, Marx assumes a uniform rate of exploitation "because... different rates of exploitation among different classes of workers [sic.] are not compatible with Marx's view of the polarization of society into two classes, capitalists and workers." However, whether workers are exploited at the same or at different rates, the fact remains that they are exploited, and so they belong to the same class, namely, the *class of the exploited* (as opposed to the *class of the exploiters*.) Marx was well aware that in reality there are many different rates of exploitation, and his reasons to assume a uniform rate bear no relation to Morishima's thinking:

> Such a general rate of surplus-value has been assumed by us for the sake of theoretical simplification... In reality there exists only approximation (Marx, 1967:3:175.)

[7]Actually, this denomination is not used by Marx. It is due to G. Sorel (1897.)

[8]This assumption will be removed later on (see Section IV below.)

[9]Marx investigates this problem in Section 2, Chs. VIII, IX, and X of the third volume of *Capital*.

[10]This drive for mechanization is —as we will see later— the basic component in Marx's theory of competition.

[11]"The price of production is (...) the centre around which the daily market-prices fluctuate and tend to equalize one another within definite periods" (Marx, 1967:3:179.) Prices of production are *ex-post* average prices and they have nothing to do with the so-called "long run equilibrium prices" of neoclassical economics. Later on we will see what happens when the two concepts are confused (see Section V below.) The notion of prices of production as centers of gravity of market prices has been examined by Semmler (1984.)

[12]"Such capital as contain a larger percentage of constant and a smaller percentage of variable capital than the average social capital are called capitals of *higher* composition, and, conversely, those capitals in which the constant is relatively smaller, and the variable relatively greater than the average social capital, are called capitals of *lower* composition. Finally we call those capitals whose composition coincides with the average, capitals of average composition (...)

The value of the commodities produced by capitals [of higher composition] would (...) be samaller than their price of production, the price of production of the commodities [produced with capitals of lower composition] smaller than their value, and only in the case of capital (...) in branches of production in which the composition happens to coincide with the social average, would value and price of production be equal" (Marx, 1967: 3:163-64.)

[13]"Apart from the domination of prices and price movements by the law of value, it is quite appropriate to regard the values of commodities as not only theoretically but also historically *prius* to the prices of production " (Marx, 1967:3:177. Emphasis in original.)

"The exchange of commodities at their values, or approximately at their values, thus requires a much lower stage than their exchange at their prices pf production, which requires a definite level of capitalist development" (Marx, 1967:3:177.)

[14]Paul Samuelson —who is far from suspiction of being a Marxist— tells the following anecdote:

"Some twenty years ago at a conference at American University, I touched a filial nerve in John Maurice Clark when I cast some doubts about his father's belief that he, John Bates Clark, had irrefutably proved in the last decade of the last century the ethical justness of the marginal productivity mode of distribution. In his reply J.M.Clark said that his father had been deeply concious of the challenge offered by Marx's notion of exploitation ("under whose theory any share capital gets is outrigh robbery") and felt under a necessity to defend the competitive system from those charges, which if true would have admittedly constituted a grave indictment" (Samuelson, 1971: 423.)

[15]Landmarks in the discussion are Bortkiewitz (1907b), Winternitz (1948), Seton (1957), Samuelson (1971), Morishima (1973), Laibman (1974), Steedman (1977) and Shaikh (1982.)

[16]Bortkiewitz (1907b) provides a numerical example. (See also Vegara, 1979, pp. 133-135.)

§ II. ARGUMENTATION OF THE LFTRP BY MARX

Marx develops the LFTRP in terms of the value system (Marx, 1967:3:Part III.) For this reason, in order to facilitate the presentation of his argument we will use the value model associated with the two-sector economy described in the previous section. The model is the following:

$$\left.\begin{aligned}\lambda_1 &= a_{z1}\lambda_z+\omega l_1\lambda_1+l_1(1-\omega\lambda_1)\\ \lambda_z &= a_{zz}\lambda_z+\omega l_z\lambda_1+l_z(1-\omega\lambda_1)\end{aligned}\right\} \quad [1.a],[1.b],$$

where $a_{z1}\lambda_z=c_1$, $\omega l_1\lambda_1=v_1$ and $l_1(1-\omega\lambda_1)=s_1$ $(i=1,2)$. Let x_1 be the total output of sector i $(i=1,2)$ per period of production (e.g., per year.) We have:

$$C=\Sigma c_1x_1=\Sigma a_{z1}\lambda_z x_1=\lambda_z(a_{z1}x_1+a_{zz}x_z)=\lambda_z\Theta \qquad [2]$$

$$V=\Sigma v_1x_1=\Sigma\omega l_1\lambda_1x_1=\omega\lambda_1(l_1x_1+l_zx_z)=\omega\lambda_1L \qquad [3]$$

$$S=\Sigma s_1x_1=\Sigma l_1(1-\omega\lambda_1)x_1=(1-\omega\lambda_1)L, \qquad [4]$$

where $\Theta=a_{z1}x_1+a_{zz}x_z$ is the physical amount of capital goods input used up in the economy during one period of production, and $L=l_1x_1+l_zx_z$ is the amount of direct labor input. If there are N workers involved in production and each works for t hours per period (i.e., the length of the "working period" is t hours), then expressions [3] and [4] can be written in the form

$$V=\omega\lambda_1Nt \qquad [5]$$

$$S=(1-\omega\lambda_1)Nt \qquad [6]$$

It follows from the above definitions that

$$\text{(a)} \quad \epsilon=\frac{S}{V}=\frac{1-\omega\lambda_1}{\omega\lambda_1} \qquad [7]$$

$$\text{(b)} \quad \Omega=\frac{C}{V}=\left(\frac{\lambda_2}{\lambda_1}\right)\left(\frac{1}{\omega t}\right)\left(\frac{\Theta}{N}\right)=\left(\frac{\lambda_2}{\lambda_1}\right)\left(\frac{1}{\omega t}\right)\Gamma, \qquad [8]$$

where $\Gamma=\Theta/N$ is an index of the degree in which capital input (in physical terms) and labor input (as measured by the number workers) are used in production. Marx calls this index the ***technical composition*** of capital.

$$\text{(c)} \quad \sigma=\frac{S}{C+V}=\frac{(1-\omega\lambda_1)L}{\lambda_2\Theta+\omega\lambda_1 L}=\frac{\epsilon}{\Omega+1} \qquad [9]$$

With these definitions at hand, the development of the LFTRP by Marx can be easily traced. Marx begins with the idea that the urge for profit forces capitalists to undergo a fierce competition against each other. From the point of view of each individual capitalist, the competitive struggle is aimed at driving his rivals from the field and capturing their share of the market. With this purpose in mind many different weapons are used in the battle, including advertising and even sabotage. Ultimately, however, the only method by which one capitalist can secure (a) that he will drive some of his rivals from the field; and (b), that others will not do the same to him, is to sell at a lower price than his competitors. Now,

> In order to be able to sell more cheaply without ruining himself, he must produce more cheaply, that is, raise the productivity of labor as much as possible (Marx, 1977:9:222.)

Once again, many methods can be devised for this purpose.

For instance, the capitalist could try to be a ***paternalistic*** employer. If this strategy should fail, he could try its opposite. (e.g., he could lay off some employees to set the example.)[1] Nevertheless, the ability of such methods to raise labor productivity has definite limits, and once those limits are reached, lower production costs can only be achieved by means of mechanization. As Marx (1977:9:222) puts it,

> the productive power of labor is raised, above all, by a universal and continual improvement of ***machinery*** (Marx's emphasis.)

For the capitalist who moves first to adopt a new technology it becomes possible, owing to his lower cost of production, to undersell his rivals and win additional share of the market at their expense. Marx (1977:9:223) puts it as follows:

> If now, by the utilization of new machines and their improvement, one capitalist has found the means of producing [more cheaply] than his competitors (...), how will this capitalist operate? He could continue to sell at the old (...) price; this would, however, be no means of driving his opponents from the field and enlarging his own sales (...); consequently, our capitalist will sell his [product] more cheaply than his competitors. [In this way] he attains the object he wishes to attain (...) He drives his rivals from the field, he wrests from them at least a part of their sales, by ***underselling them*** (Marx's emphasis.)

Faced with this reality, the rival capitalists have no choice but to adopt the same technology, and this puts everyone in the position of having to start the same process all over. As Marx (1977:9:223-24) expresses it,

> the ***privileged position*** of [the innovative] capitalist is not of long duration; other competing capitalists introduce the same machines, introduce them on the same or on a larger scale (...) The capitalists find

> themselves, therefore, in the same position relative to one another as *before* the introduction of the new means of production (...) [And] on the basis of the new cost of production the same game begins again (...) more machinery (...) (Marx's emphasis.)

In Marx's view, this process raises the technical composition of capital, so we have

PROPOSITION 1. Mechanization raises Γ.

Furthermore, the increase in the technical composition of capital is *mirrored* by an increase in the organic composition, i.e.

PROPOSITION 2. Mechanization, by way of increasing Γ, also increases Ω.

Finally, according to Marx the increase in the organic composition of capital results in a lower average rate of profit, i.e.

PROPOSITION 3. The increase in Ω lowers σ.

The Counteracting Influences

Marx completes the development of the LFTRP with the citation of a series of ***counteracting*** elemets to the fall in the rate of profit. He lists six of them (see Marx, 1967:3:232-40), namely: (1) Increasing intensity of exploitation, (2) depression of wages below the value of labor-power, (3) relative overpopulation, (4) foreign trade, (5) cheapening of the elements of constant capital, and (6) the increase of stock capital. Of these, the last one refers to the way in which the average rate of profit is computed, and it is not clear at all why it should be a counteracting force to the fall in the rate of profit.[2] The same applies to the "depression of wages below the value of labor-power."

Marx (1967:3:235) says that "it is one of the most important factors checking the tendency of the rate of profit to fall"; but it is hard to see why. In reality the wage *cannot* fall below the *value of labor-power* because (by the definition of labor-power) it would be insufficient to buy the "means of subsistence necessary for the maintenance of the labourer." What can be a counteracting force to the fall in the rate of profit is the decrease in the *value of the real wage* which goes *pari passu* with mechanization. Since λ_1 is the total labor-time (direct and indirect) necessary to produce one unit of commodity 1 (i=1,2), its inverse $1/\lambda_1$ is the amount of that commodity which can be produced with one unit of labor-time (direct and indirect.) Mechanization raises that amount , therefore it lowers λ_1 and the value of the real wage $\omega\lambda_1$. Since the organic composition of capital varies inversely with $\omega\lambda_1$ (see expression [8] above), it follows that the rise in the technical composition brought about by mechanition is not translated in the same proportion into an increase in Ω (expression [8] above). This way (through preventing the organic composition from rising as much as it would otherwise) the decrease in the value of the real wage checks the fall in the rate of profit (see expression [9] above.)

The cheapening of elements of constant capital is closely related to what has just been said. Total constant capital is $C=\lambda_2\Theta$ (see expression [2].). Mechanization raises Θ and this tends to increase C. But mechanization also lowers λ_2 and this prevents C from rising at the same rate as Θ. To be sure, "in iso-

ated cases the mass of the elements of constant capital [Θ] may even increase, while its value [C] remains the same or falls " (Marx, 1967:3: 236.) In other words, due to the decrease in λ_z the total constant capital does not increase as much as it would otherwise. There follows a check to the fall in the rate of profit: since $\sigma=S/(C+V)$, the lower the increase in C the lower the fall in σ.

Increasing the intensity of exploitation contemplates the possibility that capitalists attempt to hinder the fall in the rate of profit by means of *ad hoc* measures such as lengthening the working-period and intensifying labor (see Marx, 1967:3:232: 33.) There seems to be a great deal of confusion as to how the first of these two measures operates. Sweezy (1942:98) asserts that "Lengthening the working [period] directly raises the rate of surplus value by increasing the amount of surplus labor without affecting the amount of necessary labor." But this seems to be incorrect. It is true that a rise in t increases S (see expression [6] above) without affecting λ_j. However, it is not true that as a result of it the rate of exploitation must increase. This is so because (as expression [7] indicates) ϵ is independent of the length of the working period. (Which is logical because an increase in t not only raises S but also V —see expression [5] above— so that the rate of exploitation may well remain unchanged.) Lengthening the working period counteracts the fall in the rate of profit, not by raising the rate of exploitation, but by slowing down the increase in the organic composition. This fol-

lows from the fact that as t rises so does V but not C. (The same result can be seen through expression [8] above: mechanition raises Γ and this tends to increase Ω; but if at the same time t is raised, Ω will not increase at the same rate as Γ.)[3]

Matters are more clear as to the explanation of how intensifying labor prevents the rate of profit from falling. Speed-up and stretch-out raise the productivity of labor in the sense that they result in more output in the same time, thereby reducing the "necessary labor time," λ_i (i=1,2.) This way they raise the amount of surplus value (see expression [4] above) and lower the value of the total investment ($C+V=\lambda_2\Theta+\omega\lambda_1 L$). It follows that the rate of profit tends to increase on account of both a higher numerator and a smaller denominator. Sweezy (1942: 98) expresses this counteracting effect in a different way:

> Speed-up and stretch-out (...) raise the rate of surplus value through compressing necessary labor into a shorter time and hence leaving a larger proportion of an unchanged working [period] for surplus labor.

In summary, while lengthening the working period tempers the fall in the rate of profit by slowing down the increase in the organic composition, intensifying labor produces the same result by increasing the rate of surplus value.

Foreign trade helps to offset the fall in the rate of profit by allowing the use of imported inputs whose value is below what it would be if those inputs were produced at home. "Since foreign trade partly cheapens the elements of constant capital, and partly the necessities of life for which the variable capital

is exchanged, it tends to raise the rate of profit by increasing the rate of surplus-value and lowering the value of constant capital" (Marx, 1967:3:237.)

Relative overpopulation. The explanation of how this factor contributes to impede the fall in the rate of profit is rather confusing. Marx (1967:3:236) begins by pointing out that in the process of mechanization some degree of over-population (in other words unemployment) is created. He then stresses that on the basis of these unemployed workers,

> new lines of production are opened up, especially for the production of luxuries, and it is these that take as their basis this relative over-population (Marx, 1967:3:237.)

It follows that in these new lines of production "the variable capital makes up a considerable portion of the total capital (...), so that the mass of surplus-value" that they generate is "unusually high" (Marx, 1967:3:237.) At this point he appears to assume that for that reason such industries will enjoy rates of profit above those of the old (*more mechanized*) branches of production, and "since the general rate of profit is formed by levelling the rates of profit of the individual branches of production," (Marx, 1967:3:237), the creation of the new (*less mechanized*) industries tends to increase the general rate of profit. Sweezy (1942:99) buys this argument at face value:

> the existence of unemployed laborers is conductive to the setting up of new industries with a relatively low organic composition of capital and hence a relatively high rate of profit. When these relatively high rates of profit are averaged in with the rates of

> profit obtaining in the old industries, they raise the overall rate of profit.

However, there are a few problems with Marx's argument. In the first place, it is not clear why the new industries should be less capital-intensive than the ones in operation. Secondly, even if they were, it would be irrelevant to the issue at hand because —as it can be shown (see Bortkiewitz, 1907b)—***luxury industries do not participate in the formation of the general rate of profit.*** Lastly, we have seen in the previous section that one characteristic of the transformation of values into prices of production is that the individual capitalists do not retain the surplus-value (nor, therefore, the profit) generated in their own industries. In the formation of the average rate of profit, surplus-value is redistributed from industries with low organic composition to industries with high organic composition, so that it is not evident that the former necessarily enjoy higher profit rates than the latter. It is more appropriate to say that the creation of labor-intensive industries —if it does happen at all— counteracts the fall in the rate of profit by preventing the organic composition from rising as much as it would otherwise.

What Marx 'really' meant

With so many ***counteracting forces*** at work, one wonders what exactly Marx means by the LFTRP. The questions are, (1) Does the rate of profit ***actually*** fall? And (2) if so, is its fall ***continuous*** or only a long run ***trend***? There is a great deal of confusion around these issues and Marx is partly responsible

for it. On the one hand the very use of the word *tendency* is misleading [4] On the other, consider the following statements:

> [Mechanization] produces (...) a continuosly rising organic composition of the total capital. The immediate effect of this (...) is represented by a *continually* falling general rate of profit (Marx, 1967:3: 213. Emphasis added.)

So it appears that the rate of profit falls all the time Yet Marx (1967:3:213) points out immediately that

> this fall does not manifest itself in an absolute form, but rather as a tendency toward a progressive fall

This happens because of the counteracting factors,

> which cross and annul the effect of the general law, and which give it merely the characteristic of a tendency, for which reason we have referred to the fall of the general rate of profit as a tendency to fall (Marx, 1963:232.)

And finally, he declares that

> We have thus seen in a general way that the same influences which produce a tendency in the general rate of profit to fall, also call forth counter-effects which *hamper, retard, and partly* paralyze this fall. The latter *do not* do away with the law, but impair its effect. Otherwise, it would not be the fall of the general rate of profit, but rather its relative slowness, that would be incomprehensible. Thus, the law acts only as a tendency. And it is only (...) after long periods that its effects become strikingly pronounced (Marx, 1967:3:239. Emphasis added.)

Only one reasonable conclusion can be derived from this. Ronald Meek (1967:134-35) expresses it as follows:

> Marx can...be justly criticized for a certain lack of rigour... In some contexts he speaks of the falling tendency of the rate of profit in terms which suggest that he believed that it would tend to fall more or less continuously... In actual fact, however, all that his argument as it stands allows us to say is that... there will eventually come a point beyond

> which no conceivable [countertendency] could possibly prevent...[the rate of profit] from falling below its original level... it is also clear that in the intervening period... the rate of profit may well *rise* above its original level (Original emphasis.)

This is how many Marxists interprete the word *tendency* in the context of the LFTRP, i.e.: that due to the continual mechanization of production the rate of profit exhibits a *downward trend*. But many other Marxists have a different understanding of the problem. In a recent book which is widely used for pedagogical purposes throughout British and American universities, Fine and Harris (1979:64-65) put forth this interpretation of the LFTRP:

> A second meaning is that if one abstracts from the counteracting influences one identifies an 'underlying' direction of movement of the rate of profit. This interprets a tendency as a proposition developed at a certain level of abstraction which by itself yields no general predictions about movements in the rate of profit.

This claim is partly correct. Tendencies do not necessarily have to materialized in facts. Whether this is the meaning that Marx attaches to the word *tendency* in the context of the LFTRP is quite a different problem, and we have seen some evidence that he thinks of an *actual fall*, though presumaby for the long run. In any case some compromising stand must be taken on this point. In this regard we will assume that what Marx means is what he says, *namely*, that ***(sooner or later) the continual mechanization of production does result in a lower average rate of profit.***

Section Notes

[1]In a recent paper, Hurd (1986) provides an excellent review of these two *approaches* to the labor process —*seduction* vs. *control*. He writes:

> The management of work has been influenced by two competing philosophies, Scientific Management and Human Relations (...) The basic message of the proponents of Human Relations is that if management treats workers more humanely, then workers will respond positively and their productivity will improve. This philosophy can be traced to the paternalism of many nineteenth century capitalists (...)

By contrast,

> Scientific Management adherents have argued that the best way to improve productivity is to (..) design efficient production systems and enforce production standards. The essence of Scientific Management is the dictatorial control of the labor process by mangement.

[2]"The foregoing five points [(1) to (5) above] may still be supplemented by the following, which, however, cannot be more fully treated for the present. With the progress of capitalist production, which goes hand in hand with accelerated accumulation, a portion of capital is calculated and applied only as interest-bearing capital (...) This ***has no bearing on the level of the general rate of profit***, because for the latter profit=interest +profit of all kinds+ground rent, the division into these particular categories being immaterial to it (...)" (Marx, 1967:3: 240. Emphasis added.) But if the interest-bearing capital has nothing to do with the level of the general rate of profit (and we will see in Section V below that this is true), how can this be affected by it in any way whatsoever?

[3]It may well be that this is what Marx tries to say. But his presentation of the issue (see Marx, 1967:3:233) is so confusing that the reader can hardly know for sure.

[4]The issue of *tendency laws* is an aspect of classical economics whose interpretation appears very unclear. Marx was not the only classical economist to develop arguments in terms of tendency laws. Malthus and Ricardo before him, and after him, John Stuart Mill, all did the same. But they all forgot to explain unam biguously what they were doing. Some interesting comments are provided by Sowell (1974:112-148), Blaug (1980a: Chap. 3), and Blaug (1980b: Chap. 2.) The issue, however, is far from resolved.

§ III. EVALUATION OF THE LFTRP: (1) THE VALUE SYSTEM

PROPOSITION 1 In Marx's argument implicitly assumes that presupposing the existence of an index of the mass of means of production and an index of the mass of labor-power, we can expect the former to rise faster (or to drop slower) than the latter as technical progress takes place. In other words, the proposition assumes that over the long-period technical progress is ***capital using-labor saving.*** What reasons did Marx have to make this assumption? In the previous section we pointed out that he conceived of technical progress as ***a means for capitalists to fight the war of competition.*** Since competition is fought, above all, by the cheapening of the commodities —or, what amounts to the same thing, by lowering the unit cost of production, Marx supposes that technical progress follows a definite pattern, namely, only those techniques which do not increase production costs per unit of output are adopted. Nevertheless this is no reason to assume that such techniques have to be more capital intensive than the ones already in operation —nothing in theory prevents them from being more labor intensive. Marx also conceived of technical progress as ***a weapon to ensure capitalist control over the labor force:***

> The self-acting mule, the greatest invention of modern industry, put out of action the spinners who were in revolt (Marx, 1976:6:207.)

Nonetheless it would be far-fetched to propose that this latter motive is the driving force of technical progress —and indeed Marx himself minimizes its overall importance.

Now despite the fact that it is not self-evident, the assumption of a capital-using bias in technical progress has always been popular among economists. Even some of the otherwise severe critics of Marx (including Taussig, J.B. Clark and Böhm-Bawerk, to quote only a few) made use of it in their writings. Some contemporary writers, however, have been less willing to accept it without question, among them Robinson (1937) and Blaug (1960 and 1985.) In their opinion, there is no reason to expect technical progress to be biased "one way or the other." Their explanation is simple. On the one hand, technical progress cheapens the means of production and this will induce capitalists to substitute capital for labor. On the other hand, it also cheapens the means of subsistence —thereby reducing the cost of labor, and this will induce capitalists to substitute labor for capital. Hence, one type of bias should be compensated by the other. This argument has some theoretical merit, but only if the word ***should*** is replaced by ***could***, i.e. one type of bias ***could*** be compensated by the other. Whether or not it actually ***does*** is an entirely different question, which recent empirical evidence answers in a negative way. For example, in her input-output analysis of the structural change in the American economy over the period from 1939 to 1961, Anne Carter (1970:150 and 218) concludes that "direct labor saving is the most striking feature

of structural change. Labor coefficients decrease over time in virtually all sectors and fall relative to other input coefficients." Similar results are reported by INSEE —the government bureau of statistics— for the French economy over the period from 1959 to 1972 (see INSEE, 1974.)

PROPOSITION 2 is far more polemic because it is unclear why the organic composition should vary directly with the technical composition of capital. Marx probably had some intuitive reasons to assume that it would happen, but his theory as it stands does guarantee that result. Given the real wage and the length of the working period, expression [8] in the previous section, ie.,

$$\Omega=\left(\frac{\lambda_2}{\lambda_1}\right)\left(\frac{1}{\omega t}\right)\Gamma, \qquad [1]$$

shows that Ω depends *both* on Γ *and* on the ratio λ_2/λ_1. Automation raises Γ and hence it tends to raise Ω. Now, automation also lowers the unit value of the commodities. How their ratio λ_2/λ_1 will change is indeterminate; but if it decreases, Ω will also tend to fall. Thus, the final change in Ω will depend on how strong these two effects are. Theoretically, Ω may increase, decrease or remain unchanged. This indetermination can be resolved in favor of Marx only if it is assumed that the ratio λ_2/λ_1 either increases or remains constant. However, this assumption is unwarranted because it rules out the possibility that automation lowers the unit value of consumer goods faster than the unit value of capital goods —a possibility which cannot be

excluded *a priori*. That is, however, the procedure followed by Shaikh (1978b:250), who simply assumes that λ_2/λ_1 remains constant:

> In deducing the general law Marx abstracts from any long-term differential movements in the unit value of the two departments —precisely because all capitals are subject to the necessity of technical progress.

However, while it is clear that "all capitals are subject to the necessity of technical progress," it is not so clear that technical progress should increase productivity at the same rate in every sector of the economy —which is what Shaikh's assumption implies. He does not solve the problem posed above but simply ignores it —which is unacceptable.

Fine and Harris (F&H, 1979:59) and John Weeks (1981: 198) also try to validate Marx's second proposition. They claim that the criticism under consideration is based on a confusion: in their view, none of the critics have really understood what Marx means by *organic composition*. They base this claim in the following quotation from Marx (1967:1:612):

> I call the former the *value composition*, the latter the *organic composition*. Between the two there is a strict correlation. To express this, I call the value composition, in so far as it is determined by its technical composition and mirrors the changes in the latter, the *organic composition* of capital.

This paragraph is itself rather confusing. Marx seems to distinguish the *organic* composition from the *value* composition, but the nature of their distinction is unclear. Thus F&H and John Weeks offer the following interpretation. Production is not instantaneous but rather takes time. Consider, for instance, the

case of our two-sector model economy: at the beginning of a period of production, the capitalists buy capital goods and labor-power which are then used to produce consumer goods (sector 1) and more capital goods (sector 2.) By the end of the period, the outputs are ready to be sold according to some values. These, in general, differ from those at which the inputs were bought because they are the result of a different process of production. Now let us assume that at the beginning of period 1 mechanization is undertaken in both sectors of the economy, thereby giving rise to a new technical composition of capital, $\Gamma(1)$. On the basis of this new composition, production takes place over the period and by the end of it some values $\lambda_1(1)$ and $\lambda_2(1)$ are formed. The question is, should $\Gamma(1)$ be valorized at these values or at those which prevailed at the beginning of the period ? Reasonably, $\Gamma(1)$ should be valorized according to the latter, $\lambda_1(0)$ and $\lambda_2(0)$. Based on this, F&H and John Weeks conclude that the ***value composition*** is the technical composition valorized by the *new* values whereas the ***organic composition*** is the technical composition valorized by the *old* ones. This is a sound interpretation of Marx's quoted paragraph, but the conclusion which F&H and John Weeks derive from it does not seem so. They say,

> Technical change necessarily involves a rise in the organic composition [because the latter] is the technical composition valorized by the old values (John Weeks, 1981:199; similar paragraph in F&H, 1979: 59.)

This conclusion does not follow from its premises. When the in-

puts used up in period 1 are valorized by the values formed in period 0, the organic composition is given by

$$\Omega(1)=\left(\frac{\lambda_2(0)}{\lambda_1(0)}\right)\left(\frac{1}{\omega t}\right)\Gamma(1),$$

and for the next period,

$$\Omega(2)=\left(\frac{\lambda_2(1)}{\lambda_1(1)}\right)\left(\frac{1}{\omega t}\right)\Gamma(2).$$

We know that (i) $\Gamma(2)>\Gamma(1)$ because automation raises Γ; (ii) ω and t are constant by assumption; and (iii), $\lambda_1(1)<\lambda_1(0)$ and $\lambda_2(1)<\lambda_2(0)$ because automation lowers the unit value of the commodities. From (iii) we only can infer that $(\lambda_2(1)/\lambda_1(1)) \gtrless (\lambda_2(0)/\lambda_1(0))$. Now we can see that, on the one hand, automation tends to make $\Omega(2)>\Omega(1)$ because of (i) and (ii), but on the other hand it tends to make $\Omega(2)<\Omega(1)$ when $(\lambda_2(1)/\lambda_1(1))<(\lambda_2(0)/\lambda_1(0))$, in which case we cannot know if $\Omega(2) \gtrless \Omega(1)$ in the overall. This indetermination can be resolved in favor of the argument put forth by F&H and John Weeks, only if we assume that $(\lambda_2(1)/\lambda_1(1))\geq(\lambda_2(0)/\lambda_1(0))$, which cannot be done because it contradicts (iii.) We are thus in the same situation as before. The error of F&H and John Weeks is that they want to valorize the inputs used up in the current period by the values formed in the previous one, but they do not want to apply the same rule to inputs used up in the next period. Hence, we may conclude our discussion of Marx's *PROPOSITION 2* saying that it is unwarranted.

Nevertheless, let us assume that automation indeed raises the organic composition of capital, so that we may proceed to discuss *PROPOSITION* 3. The problem here is that even within Marx's own logical argument, there is no basis to state that increases in the organic composition will sooner or later lower the rate of profit. The reason, as pointed out earlier, is that automation increases not only the organic composition (assuming it actually does so) but also the rate of surplus-value. Now, expression [9] in the previous section, i.e.

$$\sigma=\frac{S}{C+V}=\frac{(1-\omega\lambda_1)L}{\lambda_2\Theta+\omega\lambda_1 L}=\frac{\epsilon}{\Omega+1} \qquad [2]$$

tells us that unless the increase in the organic composition is shown to overcome the increase in the rate of surplus-value we cannot say that the rate of profit will fall. Nor is there any point in saying that it exhibits a ***tendency*** to fall. As long as the indetermination remains, it would be equally correct to say that the rate of profit exhibits a tendency ***to rise***.

Many arguments have been tried in order to solve this problem. One of them goes that ***whereas the organic composition can rise without limit, the rate of surplus-value cannot*** (Mandel, 1962:1:212-13; Mattick, 1969:62; Bullock and Yaffe, 1975: 20.) This argument is fallacious. Mechanization persistently lowers λ_1, and we know by expression [7] in the previous section that the rate of surplus-value will rise as long as λ_1 drops:

$$\lim_{\lambda_i \to 0} \epsilon = \lim_{\lambda_i \to 0} \frac{1-\omega\lambda_i}{\omega\lambda_i} \to \infty$$

Hence the idea that the rate of surplus-value has an ***upper limit*** must be founded on a mathematical error, and so it is: instead of $\epsilon=(1-\omega\lambda_i)/\omega\lambda_i$, the proponents of the ***upper limit argument*** use the following alternative expression of the rate of surplus-value (notice that the formula is actually the same, only that it is not simplified one step further):

$$\epsilon=\frac{S}{V}=\frac{L-\omega\lambda_i L}{\omega\lambda_i L} \qquad [3]$$

Now the argument goes that since total surplus-value $S=L-\omega\lambda_i L$ cannot be greater than the total living labor L, the numerator of [3] has a theoretical maximum equal to L. Hence, the argument ends, if the numerator has a maximum so must have the entire ratio. This is false. Total surplus-value is L only when $\omega\lambda_i L=0$, and in this case $\epsilon=\infty$. In other words, the mass of surplus-value approaches its theoretical maximum as total variable capital approaches zero, and as this happens the rate of surplus-value approaches infinity. The argument of an upper limit of the rate of surplus-value is mathematically faulty and economically unsound —what does it mean that total variable capital is zero? More to the point, if the validity of the LFTRP depended on the alleged existence of an upper limit of the rate of exploitation one would have to conclude that —***since variable capital has***

never been zero— the LFTRP never in history has been at work. This surely *is not* what Marx had in mind.

Anwar Shaikh (1978a:223 and 1978b:239-40) has tried a different route which, althought more promising for empirical purposes, ends up at a similar theoretical point. Shaikh's argu ment entails the switching of the discussion from an upper limit of the rate of surplus-value to an *upper limit of the rate of profit*. It is developed along the following lines. Given that the mass of surplus-value is the difference between the amount of living labor (L) and total variable capital (V), the *actual rate of profit* may be expressed in the form $\sigma=(L-V)/(C+V)$. Shaikh then defines the *maximum rate of profit* as that which would be obtained if V were squeezed to zero —as Marx puts it, if workers could *live on air*, i.e., $\sigma_M = L/C$. He concludes (Shaikh, 1978a:233):

> Now, if a rising technical composition does indeed reflect itself as a rising ratio C/L —hence a falling ratio L/C— then the actual rate of profit will be progressively squeezed between a descending ceiling and an unyielding floor, so that it must itself exhibit a downward tendency.

And also (Shaikh, 1978b:240):

> The proposition that mechanization (...) lowers the maximum rate of profit would appear to imply that *sooner or later* the actual rate of profit must necessarily fall. (Enphasis in original.)

This argument seems to be correct at first glance, but a closer scrutiny shows that it is not. For let us accept that automation does lower the maximum rate of profit. It does not follow from this that the *actual rate of profit* must also decrease. That

would require not only that σ_M fell, but also that it converged Otherwise σ_M may decrease without ever forcing σ to fall: they might just approach each other asymptotically (see Figures 3.1 and 3.2 below.) Hence, what is necessary to validate the argument put forth by Shaikh is a proof that σ_M converges either toward zero or to a level below the original level of σ. Such a proof is yet to be provided.

Marx's Argument as An Empirical Problem

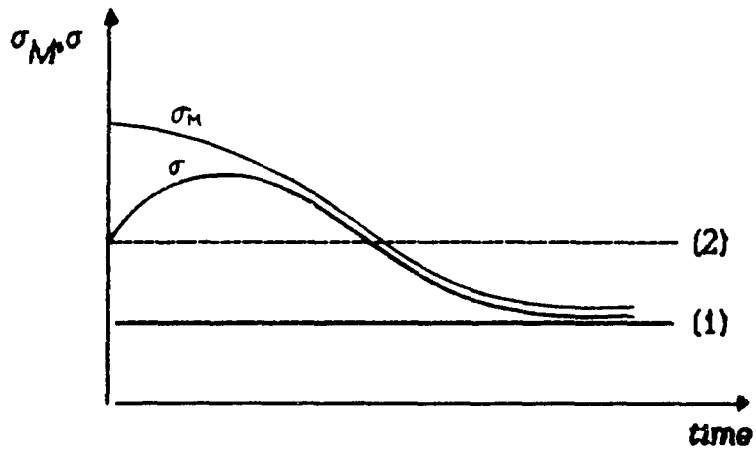
> Proceeding from the nature of the capitalist mode of production, it is thereby proved ***a logical necessity***.. a falling rate of profit (Marx, 1967:3:213. Emphasis added.)

This is incorrect. As indicated above, Marx does not prove that from the necessity of mechanization a falling rate of profit necessarily follows. His argument yields a theoretical indetermination rather than a definite conclusion. This does not mean, however, that in reality the LFTRP is not at work. The theoretical indetermination can go either way, for the affirmative or for the negative. What this means is that Marx provides an explanation for a falling rate of profit which —within the value system— can neither be 'proved' nor 'disproved' theoretically. Hence we may want to turn to empirical evidence for guidance.

Unfortunately, the empirical research in this area is faced with serious difficulties owing to the absence of statistical series for the ***labor value categories*** on which Marx's argument is based. Nevertheless something close to a test of the law has been devised. This attempt, however, is only ***indicative*** because

Figure 3.1

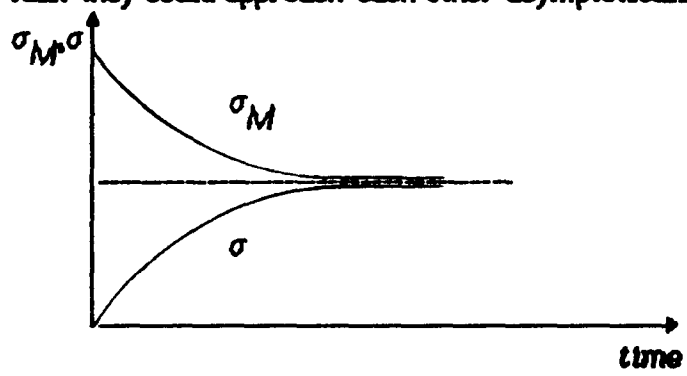
The *actual rate of profit* (σ) will fall if the *maximum rate of profit* (σ_M) also falls and converges towards a a level wich is *below* the original level of σ.



Legend: (1) *level of convergence of* σ_M
(2) *original level of* σ

Figure 3.2

If σ_M does not converge toward a level below the original level of σ, a falling σ_M *might* never force σ to fall: they could approach each other asymptotically.



it does not really test the LFTRP but rather addresses the proposition of a rising C/L ratio —a falling σ_M. Hence in no way would it be possible to reject the LFTRP on the basis of such a test. Nonetheless, if its results ran against the thesis of a rising C/L ratio, this would indeed throw dark clouds over the Marxian law. The test is as follows (see Shaikh, 1978a:232): Since C is the labor-value of the means of production, and L is the value added by living labor, their money equivalents are K, the money value of the means of production, and Y, the money value added or ***net national product.*** Hence C/L may be approximated by K/Y, the ***capital-output ratio.*** Therefore, a rising K/Y wolud mean a falling maximum rate of profit. Otherwise, one must conclude that σ_M ***does not fall over time.***

Regretably, the available estimations of the capital-output ratio provide conflicting results. Klein and Kosobud (1961) have found "a significant downward trend" for this ratio; S. Kuznets (1961) found it to be rather stable; Perlo (1966) and Shaikh (1984) claim an empirical rising trens; and finally, Gillman (1957) offers results which, depending on who interprets them, provide evidence contrary to Marx's law (Blaug, 1960) or favorable to it (Castells, 1980.) This confusing situation should not come as a surprice: experience frequently shows that what economic theory cannot prove econometrics cannot demonstrate either.

§ IV. EVALUATION OF THE LFTRP: (2) *THE PRICE SYSTEM*

Having to face theoretical indeterminations is rather uncomfortable. This is why economists of all persuasions have tried to resolve the controversy over the LFTRP. The *Okishio theorem* (Okishio, 1961) has been regarded by many, both Marxists and non-Marxists alike, as the ultimate solution of the problem. We now turn to this theorem. Consider the *price system* associated with our two-sector economy (see section I above) —and recall that so far we abstract from the existence of fixed capital (as Okishio does.) We have,

$$\left.\begin{aligned} p_1&=(a_{11}p_2+\omega l_1 p_1)(1+\pi)\\ p_2&=(a_{12}p_2+\omega l_2 p_1)(1+\pi)\end{aligned}\right\} \qquad [1.a][1.b]$$

For our present purpose it is not necessary to know the absolute prices. Hence the consumer goods may be used as the *numeraire* ($p_1=1$) and we have:

$$\left.\begin{aligned} 1&=(a_{11}p_2+\omega l_1)(1+\pi)\\ p_2&=(a_{12}p_2+\omega l_2)(1+\pi)\end{aligned}\right\} \qquad [2.a][2.b]$$

The solution $\{p_2, \pi\}$ of this sytem provides the average rate of profit and the relative price of capital goods under the ruling technique $\{ a_{11}, a_{12}, l_1, l_2 \}$. In order to find that solution, let us

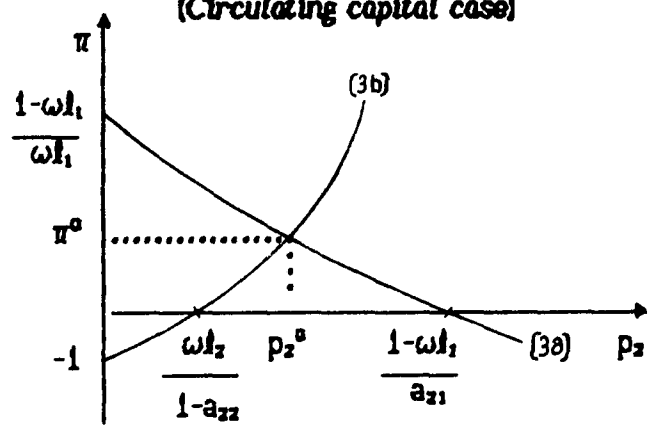
write equations [2.a] and [2.b] in the form

$$\left.\begin{aligned} \pi &= \frac{1-(a_{z1}p_z+\omega l_1)}{a_{z1}p_z+\omega l_1} \\ \pi &= \frac{p_z-(a_{z2}p_z+\omega l_2)}{a_{z2}p_z+\omega l_2} \end{aligned}\right\} \qquad [3.a]\,[3.b]$$

In Appendix II it is shown that: (1) Equation [3.a] intersects the p_z-axis at $(1-\omega l_1)/a_{z1}$ and the π-axis at $(1-\omega l_1)/\omega l_1$. (2) Equation [3.b] intersects the p_z-axis at $\omega l_2/(1-a_{z2})$ and the π-axis at -1. (3) Equation [3.a] is monotonically decreasing and equation [3.b] is monotonically increasing. In addition, for the system to be viable in the sense that it yields a positive rate of profit, it must be the case that $((1-\omega l_1)/a_{z1})>(\omega l_2/(1-a_{z2}))$. Therefore, one can derive the solution depicted in Figure 4.1. Hence under the ruling technique the average rate of profit is π^o and the relative price of capital goods is p_z^o.

Figure 4.1

Determination of the Average Rate of Profit (Circulating capital case)



Suppose now that a new technique (a^*, l^*) which reduces the unit cost of production at ruling prices is introduced in sector 1 (i= 1 *or 2*, or i=1 *and* 2.) If the innovation occurs in sector 1 we have:

$$a_{z1}{}^*p_z{}^0 + \omega l_1{}^* < a_{z1}p_z{}^0 + \omega l_1.$$

Multiplying by $(1+\pi^0)$,

$$(a_{z1}{}^*p_z{}^0 + \omega l_1{}^*)\,(1+\pi^0) < (a_{z1}p_z{}^0 + \omega l_1)\,(1+\pi^0) = 1,$$

and from here,

$$\pi^0 < \frac{1-(a_{z1}{}^*p_z{}^0+\omega l_1{}^*)}{a_{z1}{}^*p_z{}^0+\omega l_1{}^*} = \pi^* \text{ for } p_z = p_z{}^0.$$

This expression indicates that in the new price equation of sector 1 the rate of profit at the ruling prices (i.e. the ***transitional rate of profit*** in sector 1) must be ***greater*** than the ruling rate of profit. In terms of Figure 4.1 this means that the curve representing the new price equation of sector 1 lies to the right of the old curve. Therefore the new ***average*** rate of profit (π^*) must be greater than the old one (π^0). (See Figure 4.2.)

If the innovation occurs in sector 2 we have

$$a_{z2}{}^*p_z{}^0 + \omega l_2{}^* < a_{z2}p_z{}^0 + \omega l_2.$$

Multiplying by $(1+\pi^0)$,

$$(a_{z2}{}^*p_z{}^0 + \omega l_2{}^*)\,(1+\pi^0) < (a_{z2}p_z{}^0 + \omega l_2)\,(1+\pi^0) = p_z{}^0,$$

and thus,

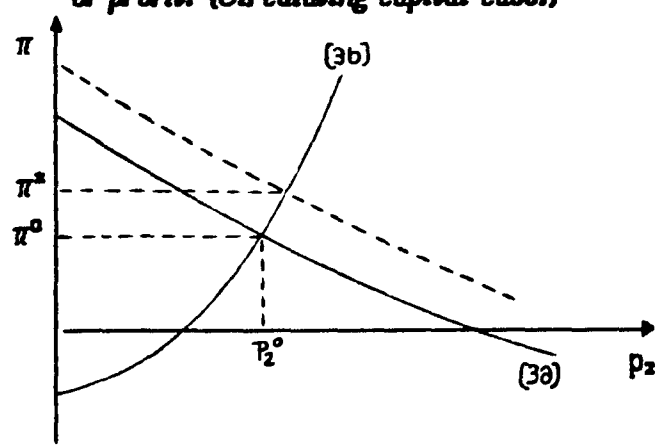
$$\pi^0 < \frac{p_2^0-(a_{zz}^*p_2^0+\omega l_z)}{a_{zz}^*p_2^0+\omega l_z} = \pi^* \text{ for } p_z=p_2^0.$$

In terms of Figure 4.1 this implies that the curve representing the new price equation of sector 2 lies *to the left* of the old curve. Hence the new *average rate of profit* (π^*) must be *greater* than the old one (π^0). (See Figure 4.3.)

It follows from above that if the innovation occurs in both sectors simultaneously (i=1 *and* 2) the same result applies, i.e. *the new average rate of profit must be greater than the old one*, this case being a mere combination of the preceding two. This is the Okishio theorem.

Figure 4.2.

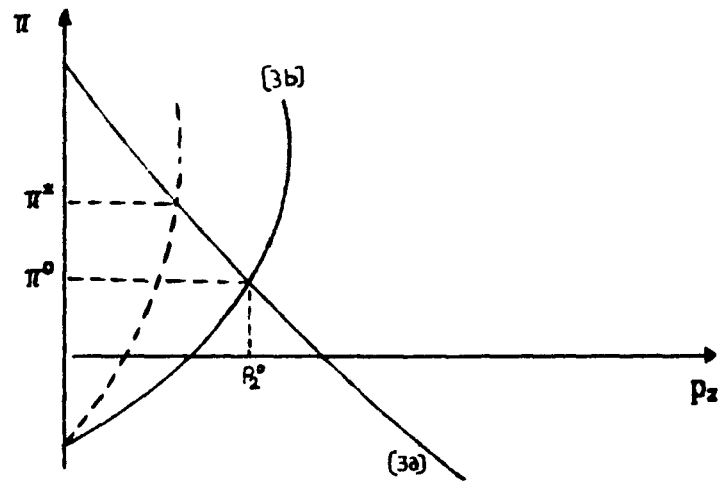
Effect of sector 1's mechanization upon the average rate of profit. (Circulating capital case.)



Note: (——) *represents the new price equation of sector 1*

Figure 4.3.

Effect of sector 2's mechanization upon the average rate of profit (Circulating capital case.)



Note: (——) *represents the new price equation of sector 2*

Fixed Capital and the Okishio Theorem

There is no doubt that the Okishio theorem seems to be a major finding, for it suggests that the indetermination regarding the effects of mechanization upon the average rate of profit is finally resolved —the LFTRP is false. But is it? So far we have only considered an economy from which fixed capital is absent. In this context, the Okishio theorem is unquestionable: if mechanization is undertaken the average rate of profit must necessarily increase. It remains to be seen what happens when the existence of fixed capital —which is the rule rather than the exception— is taken into account. In a recent article, A. Shaikh

(1978b) claims —although he does not offer a formal proof— that the Okishio theorem breaks down in the presence of fixed capital. Here we offer a simple theorem which seems to confirm such a claim.

(1) ***Determination of Prices of Production.*** In *Capital*, vol.3, Marx (1967:3:157) provides an unambiguous definition of price of production in the presence of fixed capital. Price or production is ***cost-price*** (the per unit cost of production evaluated at ruling prices) plus a percentage π (the average rate of profit) of the unit investment ***laid out*** (not merely consumed) in production.[1] This definition allows us to formulate the price of production in the following manner —we continue with the familiar two-sector economy. Let Ψ_i be the physical amount of fixed capital laid out in sector i ($i=1,2$) at the beginning of period $t=1$, and let T_i be its life. Hence, $p_2\Psi_i$ is the monetary value of the fixed capital laid out in sector i ($i=1,2$) at time $t=1$. Suppose this equipment can turn out N_i units of output in each of its T_i years of life. Then the ***average depreciation per unit*** in sector i ($i=1,2$) is $p_2\Psi_i/T_iN_i=p_2\theta_i$. This means that in sector i ($i=1,2$) one unit of output ***absorbs*** an amount $p_2\theta_i$ of fixed capital. It also absorbs an amount $p_2a_{2i}+p_1\omega l_i$ of ***circulating capital.*** Hence the ***cost-price*** is given by $p_2\theta_i+p_2a_{2i}+p_1\omega l_i$.

The ***unit investment*** laid out in production consists of two elements: the ***circulating capital*** and the ***fixed capital advanced per unit.*** The former we already know. To determine the latter, notice that in sector i ($i=1,2$) an amount $p_2\Psi_i$ of fixed capital is

advanced at the beginning of period t=1 in which N_1 units of output are produced. This means that in that sector and year an amount $p_2\Psi_1/N_1$ of fixed capital is advanced per unit of output. That amount drops to $(p_2\Psi_1/N_1)[(T_1-1)/T_1]$ in year t=2, since $p_2\Psi_1/T_1$ of the original fixed capital depreciates during the first year, etc. Over the T_1 years of life of Ψ_1, *unit advancements of fixed capital* decline as summarized in Table 1:

Table 1.
Annual advancements of fixed capital per unit of output

t=1	$(p_2\Psi_1/N_1)$
t=2	$(p_2\Psi_1/N_1)[(T_1-1)/T_1]$
t=3	$(p_2\Psi_1/N_1)[(T_1-2)/T_1]$
⋮	
$t=T_1$	$(p_2\Psi_1/N_1)(1/T_1)$

Notice that for any one year except the last (which in any case is irrelevant because, properly speaking, there is no fixed capital in it) the amount of fixed capital advanced per unit is greater than the depreciation per unit. Thus, the *average* of the annual advances of fixed capital is also greater than the unit depreciation. Using that average $[p_2\phi_1 \quad (i=1,2)]$ as a measure for the *amount of fixed capital advanced per unit*,[2] we can express the *unit investment laid out in production* as $p_2\phi_1+p_2a_{2_1}+p_1\omega l_1$ (i=1,2.) Hence the price of production in sector i (i=1,2) is

given by $p_1=(p_2\theta_1+p_2a_{z_1}+p_1\omega l_1)+\pi(p_2\phi_1+p_2a_{z_1}+p_1\omega l_1)$.

(2) Determination of the Average Rate of Profit. The above definition of price of production can be used to formulate the *price system.* Since for our present purpose it is not necessary to know the absolute prices, we may use the consumer goods as *numeraire* ($p_1=1$), so that we have

$$\left.\begin{aligned} 1&=(p_2\theta_1+p_2a_{z1}+\omega l_1)+\pi(p_2\phi_1+p_2a_{z1}+\omega l_1)\\ p_2&=(p_2\theta_2+p_2a_{z2}+\omega l_2)+\pi(p_2\phi_2+p_2a_{z2}+\omega l_2)\end{aligned}\right\} \quad [4.a][4.b]$$

The solution $\{\pi, p_2\}$ of this system provides the average rate of profit and the relative price of capital goods under the ruling technique of production $\{\theta, \phi, a_{z_1}, l_1; (i=1,2)\}$. In order to find that solution let us write equations [4.a] and [4.b] as follows:

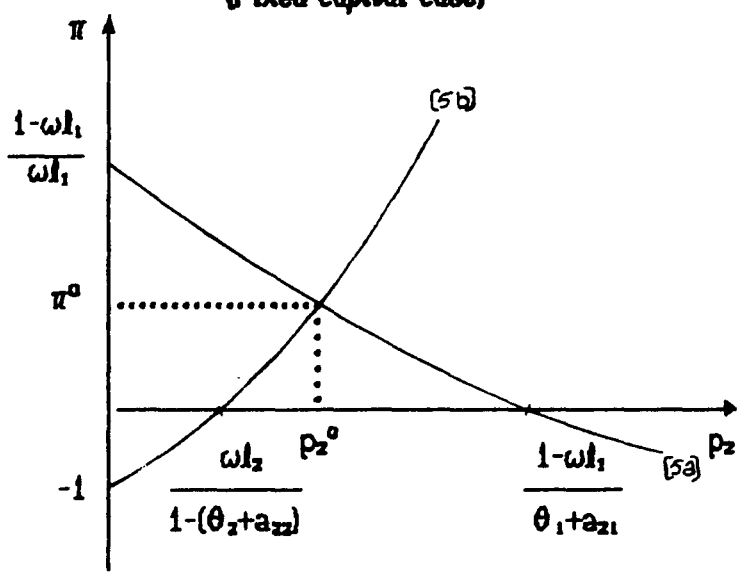
$$\left.\begin{aligned} \pi&=\frac{1-(p_2\theta_1+p_2a_{z1}+\omega l_1)}{p_2\phi_1+p_2a_{z1}+\omega l_1}\\ \pi&=\frac{p_2-(p_2\theta_2+p_2a_{z2}+\omega l_2)}{p_2\phi_2+p_2a_{z2}+\omega l_2}\end{aligned}\right\} \quad [5.a][5.b]$$

It is shown in Appendix 3 that (1) Equation [5.a] intersects the p_2-axis at $(1-\omega l_1)/(\theta_1+a_{z1})$ and the π-axis at $(1-\omega l_1)/\omega l_1$. (2) Equation [5.b] intersects the p_2-axis at $\omega l_2/[1-(\theta_2+a_{z2})]$ and the π-axis at -1. (3) Equation [5.a] is monotonically decreasing and equation [5.b] is monotonically increasing. In addition, for the system to be viable it must be the case that $[(1-\omega l_1)/(\theta_1+a_{z1})]>(\omega l_2/[1-(\theta_2+a_{z2})])$. Therefore, one can derive the solution de-

picted in Figure 4.4 (below). Hence under the ruling technique the average rate of profit is π^o and the relative price of capital goods is p_2^o.

Figure 4.4.

Determination of the Average Rate of Profit
(Fixed capital case)



(3) *Effects of Mechanization Upon The Average Rate of Profit.* Suppose a technique $\{ \theta^*, \phi^*, a^*, l^* \}$ that is *cost-price-reducing* at ruling prices is introduced in sector 1 (1=1 *or* 2, or 1=1 *and* 2.) If the innovation occurs in sector 1, we have

$$p_2^o\theta_1^* + p_2^o a_{21}^* + \omega l_1^* < p_2^o\theta_1 + p_2^o a_{21} + \omega l_1 \qquad [6]$$

Multiplying by -1, adding 1 to both sides, and dividing the resulting inequality by $p_2^o\theta_1^* + p_2^o a_{21}^* + \omega l_1^*$, we have

$$\frac{1-(p_2^0\theta_1^*+p_2^0a_{z1}^*+\omega l_1^*)}{p_2^0\phi_1^*+p_2^0a_{z1}^*+\omega l_1^*} > \frac{1-(p_2^0\theta_1+p_2^0a_{z1}+\omega l_1)}{p_2^0\phi_1^*+p_2^0a_{z1}^*+\omega l_1^*} \qquad [7]$$

If it is indeed true —as Marx (1973:776-77) suggests— that mechanization raises the *investment cost per unit of output*, i.e. if $p_2^0\phi_1^*+p_2^0a_{z1}^*+\omega l_1^* > p_2^0\phi_1+p_2^0a_{z1}+\omega l_1$, then $p_2^0\phi_1^*+p_2^0a_{z1}^*+\omega l_1^*$ can be replaced with $p_2^0\phi_1+p_2^0a_{z1}+\omega l_1$ in the right hand side of [7] to yield[3]

$$\frac{1-(p_2^0\phi_1^*+p_2^0a_{z1}^*+\omega l_1^*)}{p_2^0\phi_1^*+p_2^0a_{z1}^*+\omega l_1^*} \gtrless \frac{1-(p_2^0\phi_1+p_2^0a_{z1}+\omega l_1)}{p_2^0\phi_1+p_2^0a_{z1}+\omega l_1} \qquad [8]$$

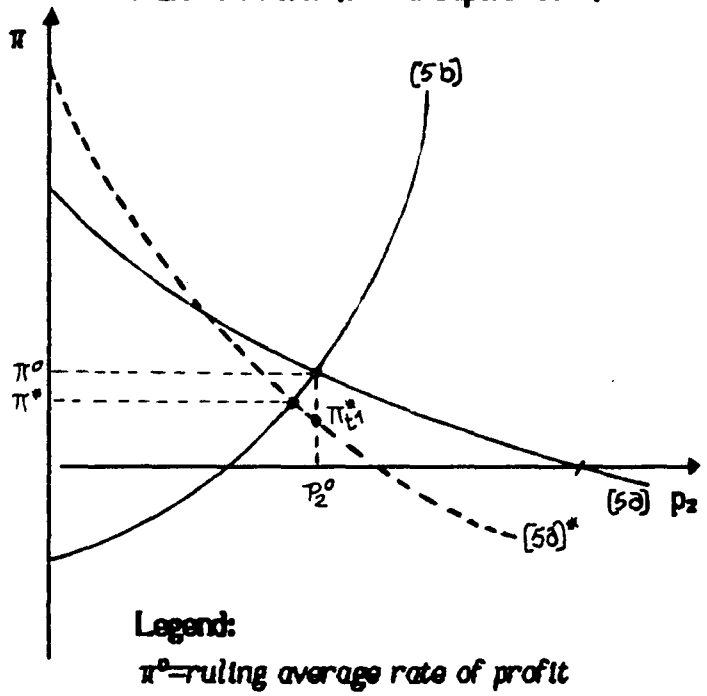
That is,

$$\pi^* \text{ for } p_2=p_2^0 \gtrless \pi^0 \qquad [9]$$

This expression indicates that in sector 1, the *transitional rate of profit* (i.e., the rate of profit which the innovative capitalist would obtain at ruling prices) may be equal, greater, or lower than the ruling average rate of profit. In terms of the mathematics of the argument, expression [9] simply says that in the new price equation of sector 1, the rate of profit at the ruling prices may be equal, higher, or lower than the ruling rate of profit. Referring once again to Figure 4.4, this means that the introduction of the new technique does not move [5.a] in a determinate direction. Hence a position such as [5.a]* in Figure 4.5. is possible, *and it entails a lower average rate of profit.* (See Figure 4.5. below.)

Figure 4.5

Effect of Sector 1's Mechanization upon the Average Rate of Profit (Fixed Capital case)



Legend:

π°=ruling average rate of profit

$\pi_{t1}^{*}=\pi^{*}$ for $p_2=p_2^{\circ}$, i.e. the transitional rate of profit (in sector 1)

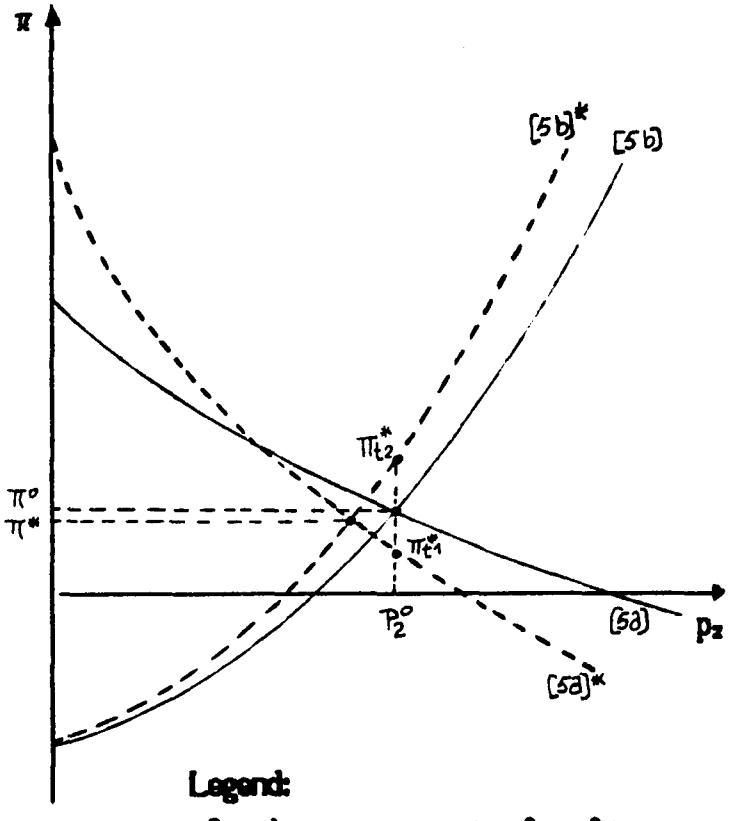
π^{*}=new average rate of profit

If the innovation occurs in the capital goods sector (i=2), we have $p_2^{\circ}\phi_2^{*}+p_2^{\circ}a_{22}^{*}+\omega l_2^{*}<p_2^{\circ}\phi_2+p_2^{\circ}a_{22}+\omega l_2$, and similar steps to those followed above[4] lead to the same conclusion, i.e. the average rate of profit *may* fall. Finally, as indicated in Figure 4.6, if the innovation occurs in both sectors simultaneously, the same result applies. (This case is a mere combination of the preceding two.) Hence we have the following *THEOREM*:

In the presence of fixed capital, if (i) capitalists innovate according to the criterion of a lower cost of production, and (ii) the introduction of more mechanized techniques raises the investment cost per unit of output, then the effects of mechanization upon the average rate of profit are theoretically indeterminate. Therefore the Okishio theorem is false.

Figure 4.6

Effect of A General Mechanization upon the Average Rate of Profit (Fixed Capital case)



Legend:

π^o=ruling average rate of profit

π_{t1}^*=transitional rate of profit in sector 1 (i=1,2)

π^*=new average rate of profit

On The Capitalist Criterion For Mechanization: *A Lower Cost of Production* or *A Higher Transitional Rate of Profit?*

Simple inspection of Figures 4.5 and 4.6 reveals the **necessary** condition under which mechanization results in a lower average rate of profit. That condition may be stated as follows:

> ***For mechanization to lower the average rate of profit, it must also lower some or all of the transitional rates of profit.***

Is there any possibility that this condition will be met in the real world? Traditional teachings suggest that there is none, as those teachings assume that it would be *irrational* for any capitalist to introduce a more mechanized technique so long as it reduces his transitional rate of profit. However, the idea of rationality that permeates this belief is too narrow. To see why, consider the case of a technique $\{ \theta^*, \phi^*, a^*, l^* \}$ which, in relation to the ruling one $[\{ \theta, \phi, a, l \}]$, lowers the unit cost of production *and* the transitional rate of profit. According to the traditional teachings, no capitalist should ever consider adopting such a technique. Suppose, however, that one "irrational" capitalist introduced it and began to cut prices. Now the others must follow, or else they will be driven from the market. (Accomplishing that outcome is precisely what the capitalist had in mind. Moreover, since he did lower the price first, he might have won some market share from his dormant rivals.) Obviously, there is a limit —determined as p_1 for $\pi=0$— below which prices cannot be cut without incurring a loss. That limit, however, is not the same for everyone. It is lower for the

["irrational"] innovator because, with $\pi=0$, the price is the cost-price, and this is lower for the new technique. It follows that the innovative capitalist can lower his price to a level which rival capitalists cannot match without incurring a permanent loss. Hence they must begin to behave "irrationally" and introduce the new technique, or else they will be driven from the field, either because they ruin themselves or because they lose their markets to the innovator. It thus seems that the traditional wisdom has got its idea of rationality reversed.

Section Notes

[1]"The price of a commodity which is equal to its cost-price plus the share of the annual avarage profit on the total capital invested (not merely consumed) in its production is called its price of production. Take, for example, a capital of 500, of which 100 is fixed capital, and let 10% of this wear out during one turnover of the circulating capital of 400. Let the average profit for the period of turnover be 10%. In that case the cost-price of the product created during this turnover will be 10c for wear plus 400 (c+v) circulating capital=410, and its price of production will be 410 cost-price plus (10% profit on 500)50= 460" (Marx, 1967:3:150.)

[2]The questions may be asked (1) why the use of linear depreciation, and (2) why measure the amount of fixed capital advanced per unit by the average of the actual annual advances. The answer is that no matter what formula for depreciation we use, and no matter whether we measure the fixed capital advanced per unit by its actual annual values or by the average of those values, it is nonetheless true that the fixed capital advanced per unit is greater than the unit depreciation, and this, as we will see, is the relevant aspect in our argument.

[3]This is the well known proposition of *increasing roundaboutness* in production, which economists usually associate with the name of Bohm-Bawerk. This is a theoretical claim which not everyone accepts (see, e.g., Blaug, 1985:506-23.)

[4]Multiply $p_z^0\theta_z^*+p_z^0a_{zz}^*+\omega l_z^* < p_z^0\theta_z+p_z^0a_{zz}+\omega l_z$ by -1, add p_z^0 to both sides, and divide the resulting inequality by $p_z^0\phi_z^*+p_z^0a_{zz}^*+\omega l_z^*$. This yields π^* for $p_z=p_z^0$ π^0.

§ V. COMPARISON WITH OTHER TREATMENTS OF THE FIXED CAPITAL MODEL

The formulation of the fixed capital price system presented in the previous section differs from other treatments of the same subject in the literature. The best example of the latter is provided by Roemer (1979 and 1981). Specifically, he discusses the LFTRP using a model in which fixed capital *lasts forever*. Theoretically, such a procedure makes sense because —as he explains— "the case of nondepreciating fixed capital is the polar opposite of the pure circulating capital case" (Roemer, 1981: 119-20), for which the Okishio theorem does hold. Hence,

> if the rate of profit can be shown to rise as a consequence of technical innovation in a model when fixed capital lasts forever, *a fortiori* it should rise when fixed capital wears out, this latter case being in some sense an average between the two polar cases (Roemer, 1981:120.)

Roemer defines prices of production —which, for unknown reason, he calls *equilibrium prices*— in the following way:

> What is the equilibrium price vector p and the profit rate π in this model? It is the pair (p, π) which makes the present discounted value (PDV) of the re-revenue stream, from operating each process at unit level, equal to zero" (Roemer, 1981:120.)

That is, using our two-sector model,[1]

$$-(p_2\xi_1+p_2a_{2_1}+p_1\omega l_1)+\sum_{t=1}^{\infty}\frac{p_1-(p_2a_{2_1}+p_1\omega l_1)}{(1+\pi)^t}=0 \qquad (i=1,2), \quad [1]$$

where $\xi_1=\Psi/N_1$ is the fixed capital input per unit of output (Ψ_1 is the physical amount of fixed capital laid out in sector 1, and N_1 is the number of units of output that this equipment turns out per period of production. Since we are assuming that fixed capital lasts forever, Ψ_1 does not depreciate, and hence ξ_1 is constant over the infinite life span of the fixed capital.) Taking the consumer goods as the *numeraire* ($p_1=1$), we have:

$$-(p_2\xi_1+p_2a_{2_1}+\omega l_1)+\sum_{t=1}^{\infty}\frac{p_1-(p_2a_{2_1}+\omega l_1)}{(1+\pi)^t}=0 \quad (1=1,2 \text{ and } p_1=1) \quad [2]$$

Since it is an identity that

$$\sum_{t=1}^{\infty}\frac{1}{(1+\pi)^t}=\frac{1}{\pi}, \qquad [3]$$

we can write [2] in the following form:

$$\pi=\frac{p_1-(p_2a_{2_1}+\omega l_1)}{p_2\xi_1+p_2a_{2_1}+\omega l_1} \quad (1=1,2 \text{ and } p_1=1) \qquad [4]$$

The solution of this system provides the average rate of profit and the relative price of capital goods, i.e. $[\pi^*, p_2^*]$ under the ruling technique $\{ \xi_1, a_{2_1}, l_1 \}$.

Suppose now that a new technique $\{ \xi_1^*, a_{2_1}^*, l_1^* \}$ is found for sector 1 (1=1 *or* 2, or 1=1 *and* 2.) Roemer puts to himself this question: "What is the capitalists' innovation criterion?" He

answers: They will adopt the new technique

> if at current prices and rate of return, the stream of discounted net revenues, is positive. That is, the *rational capitalist* treating prices as given, adopts the new technique if and only if (Roemer, 1981:121. Emphasis added):

$$-(p_2^0\xi_1^*+a_{z_1}^*p_2^0+\omega l_1^*)+\sum_{t=1}^{\infty}\frac{p_1-(a_{z_1}^*p_2^0+\omega l_1^*)}{(1+\pi^0)^t}>0 \quad (i=1,2;p_1=1) \quad [5]$$

Using this criterion for innovation, Roemer proceeds to show that the rate of profit must rise.

But of course ! Let us examine Roemer's criterion of innovation in order to see what it actually amounts to. From [5] we have, using the identity [3], that

$$\pi^0<\frac{p_1-(a_{z_1}^*p_2^0+\omega l_1^*)}{p_2^0\xi_1^*+a_{z_1}^*+\omega l_1^*}=\pi^* \text{ for } p_2=p_2^0 \quad (i=1,2 \text{ and } p_1=1), \quad [6]$$

which shows that Roemer's innovation criterion is actually the following: ***The rational capitalist will introduce a new technique if and only if it raises his transitional rate of profit !***

We have seen in the previous section that the [necessary] condition for mechanization to lower the average rate of profit, is that it must also lower some or all of the transitional rates of profits. Now Roemer tells us that mechanization will not lower the rate of profit because capitalists do not mechanize their industries *unless* it raises their transitional rates of profit. But the question is *why?* For what *reason* will capitalists

behave in that way? Roemer provides no reason other than this: because it is tautologically *rational* to do so. However, we have also seen in the previous section that such an idea of rationality is likely to end up with the capitalists who put it into practice *being driven out of the market.* So much for Roemer's *definition* of *rationality.*

In addition to the above, there is also a serious problem with Roemer's formulation of the price system itself, which appears to be an "illegitimate" invasion of neoclassical thinking into the Marxian analytical framework.[2] To see why, notice that in order to define prices via the PDV method, as Roemer does —see [1], one has to use some *rate of discount.* Roemer uses the *average rate of profit.* But is this a legitimate choice? The average rate of profit is an *END RESULT* of competition —and therefore of mechanization itself, since competition is fought by the cheapening of the commodities and this, in turn, is achieved by the continual mechanization of production. Thus, the average rate of profit is *not* something which is there "in the market" for capitalists to see and use as a criterion for evaluating potential innovations. The average rate of profit exists as a *theoretical concept,* but certainly not as a *datum* which capitalists have available for their day-to-day calculations. Now, if for the purpose of computing the present value of the future stream of net revenue, capitalists cannot use the average rate of profit, what will they use in its place? The answer is, the *rate of interest* —which, contrary to the average rate of profit, is a

datum available at all times. All that capitalists need to do in order to know it, is to ask the lenders of capital how much they are about to charge on their loaned money. Marx (1967:3:368) had all this very clear:

> The average rate of profit does not obtain as an established fact, but rather as an end result of the equalisation of opposite fluctuations. *Not so with the rate of interest.* It is a thing fixed daily in its general, at least local, validity —a thing which *serves industrial (...) capitals even as a prerequisite and a factor in the calculation of their operation.* (Emphasis added.)

In light of this, the following question is warranted: When using π as a rate of discount, is Roemer identifying the rate of profit with the rate of interest? It does seem so. To see why, let us formulate "equilibrium prices" *a la neoclassical*, using the interest rate as rate of discount. Since we could not possibly do it better than a good neoclassical economist would do it, we will use the words of R.L. Crouch (1972:67-69). Suppose that a capitalist is evaluating a project which entails the use fixed capital by the amount $p_z\xi_1$ per unit of output:

"[He] either has to borrow the money to pay for it, or [he] has to use [his] own money (...) in which case [he] *forgoes* earning the market rate of interest on that money (...) Whichever way you look at it, then, the interest cost *per period* (either explicit or forgone) is equal to the [cost of the fixed capital], i.e. $[p_z\xi_1 r]$. This is one part of the cost of buying the [fixed capital's] productive service. But it is not the whole cost. This [fixed capital] wears out, or *depreciates*, over its n year lifetime, and the entrepreneur has to allow for such depreciation.

When the [fixed capital] eventually wears out after n years the entrepreneur wants to be able to replace it. He wants to have set aside each period an amount of money d which will, at the end of n years, have accumulated to the replacement price of the [fixed capital]. Thus, apart from the interest cost per period $[p_z\xi_1 r]$ already discussed, there is a depreciation cost per period d to be calculated. How do you calculate d? (...) we wish to set aside each year a unique amount d such that the total accumulated at the end of n years is just sufficient to replace the [fixed capital]. That is (...),

$$d(1+r)^{n-1}+d(1+r)^{n-2}+.....+d(1+r)+d=[p_z\xi_1],$$

which yields

$$d=\frac{[p_z\xi_1 r]}{(1+r)^n-1} \qquad [7]$$

Expression [7] is the depreciation cost that must be incurred per period if the [cost of the fixed capital] is to be recouped over its working life. If we add to this the interest cost per period $[p_z\xi_1 r]$ incurred by buying the [fixed capital], we obtain

$$P_{cs}=[p_z\xi_1 r]+\frac{[p_z\xi_1 r]}{(1+r)^n-1} \qquad [8]$$

In the above equation P_{cs} is the total [cost] to the firm of the

capital services provided by [the fixed capital] per period."

Every period the capitalist will use, in addition to the fixed capital, raw materials and labor (i.e. *circulating capital*) by the amount $p_2a_{z_1}+p_1\omega l_1$. Again, he must either borrow this money or use his own, etc. Thus the cost to him of the circulating capital in each period is $(1+r)(p_2a_{z_1}+p_1\omega l_1)$. Adding this cost to the cost of the fixed capital, we obtain

$$p_1=p_2\xi_1 r+\frac{p_2\xi_1 r}{(1+r)^n-1}+(1+\pi)(p_2a_{z_1}+p_1\omega l_1) \qquad (i=1,2) \quad [9]$$

In the case when the fixed capital lasts forever we have

$$\lim_{n\to\infty}\frac{p_2\xi_1 r}{(1+r)^n-1}=0,$$

and therefore [9] reduces to

$$p_i=p_2\xi_1 r+(1+r)(p_2a_{z_1}+p_1\omega l_1) \qquad (i=1,2) \qquad [10]$$

Now let us go back to Roemer's formulation of *prices* as in [1]. Using the identity [3] we obtain

$$p_i=p_2\xi_1\pi+(1+r)(p_2a_{z_1}+p_1\omega l_1) \qquad (i=1,2) \qquad [11]$$

Simple inspection shows that π in [11] corresponds with r in [10]. Therefore, Roemer does indeed identify the average rate

of profit with the rate of interest, thereby confusing *prices of production* with the so-called *neoclassical long-run equilibrium prices* —whatever these may mean.

This is a serious theoretical problem. Prices of production are the average of market prices, and hence —as already mentioned— in the long-period they are "a prerequisite of supply, of the reproduction of commodities" (Marx, 1967:3:198.) If, however, the rate of interest is equal to the rate of profit, then, *on average* (i.e., over the long-period), the *industrial capitalist* who borrows capital and undertakes the investment will have no gain at all *because the profit* that *he derives from his entrepreneurial activity will have to be relinquished to the lender of capital in the form of interest payment.* Now if that were to be the case he would not undertake production at all — which only goes to say that, whatever they may be, Roemer's neoclassical prices *are not* prices of production, *simply because in the long-period they cannot ensure the reproduction of commodities.* For commodities to be reproduced over the long-run —that is to say, for capitalists to remain in business, there has to exist a *profit for the enterprise* (Marx, 1967:3:374) *after all payments, including the payment of interest, have been made.* This implies that whatever profit a capitalist derives from production must be sufficient both to pay back the interest on the borrowed money and to leave a *profit for the enterprise*, i.e *"the average profit =interest +profit of enterprise"* (Marx, 1967:3:388. Emphasis added.) Hence, the rate of profit must

be greater than the interest rate. The form in which Roemer defines his "equilibrium prices" suggests that both the lender and the borrower obtain the same *average rate of profit* on the [loaned] capital. But this is all neoclassical nonsense. In the real world, a capital of $100 is a capital of $100 dollars. If the *average rate of profit* is 10%, this capital will yield a profit of $10 (=$100 times the *average rate of profit of* 10%), *regardless of who actually invest it* in the production of commodities. If the *industrial capitalist* who undertakes production owns the $100 himself, he will keep the profit of $10. If he borrows the $100 and the interest rate is 5%, then he will have to pay $5 (=$100 times the interest rate of 5%) to the *financial capitalist* (the lender) from whom he has borrowed. Hence, he will keep (*profit of the enterprise*) $5. As Marx (1967:3:353) puts it,

> The profit is not doubled by the double existence of the same sum of money as capital for two persons. It can serve as capital for both of them only by dividing the profit.

There is only one situation in which abstracting from any quantitative difference between the average rate of profit and the rate of interest may be theoretically sound, namely, when it is assumed that there are no financial markets in the economy, so that the distinction between financial and industrial capital is superfluous. But, clearly, doing so is equivalent to abstracting from capitalism itself —and then any discussion concerning the LFTRP (or anything else) is mere theoretical divertiment.

Section Notes

[1]Notice that in the first period (period t=0) the capitalist invests an amount $p_2\xi_1+p_2a_2+p_1\omega l_1$ per unit of output —$p_2\xi_1$ is fixed capital and the rest is circulating capital. However, in the same period there is no revenue, since the output produced in that period is not sold until the next period. Thus we have:

Costs in period t=0, $p_2\xi_1+p_2a_2+p_1\omega l_1$

Revenue in period t=0, none.

In period t=1, the only cost is that of the circulating capital; there is no fixed capital cost because fixed capital lasts forever and its cost has already been paid in period t=0. In this period (t=1) the output produced in period t=0 is sold, and hence we have revenue in period 1=p_1. Periods 2, 3, etc. follow the same pattern as period t=1. Hence equation [1] in the text.

[2]This problem has been mentioned by Shaikh in his illuminating exchange with the neo-Ricardians (see Shaikh, 1980.) Our discussion of this issue owes much to him, but it also owes a great deal to Marx (1967: Chapters xxi-xxiii.). It is unfortunate that most of the discussion on Marx has concentrated on his theory of value, and so little on issues such as the theory of money and credit, to which the aforementioned chapters belong. There is much one can learn from Marx's treatment of those issues.

§ VI. CONCLUSION

It will be useful to clarify what has and has not been shown in the preceding pages. It has not been shown that the Marxian LFTRP is necessarily correct, and hence that Marx was right in saying that under capitalism economic crises are unavoidable. It has been shown, however, that no argument has so far been given which allows us to say that the LFTRP is false. In particular, it appears that the most appealing critique of the LFTRP, namely the Okishio theorem, does not hold once the existence of fixed capital is taken into acount. Therefore the LFTRP remains a valuable theoretical hypothesis.

This result has important implications. On one hand, the Marxian tradition which explains economic crises in light of the LFTRP must be given the *theoretical legitimacy* denied to it in recent years. On the other hand, the idea that economic crises are for the most part the consequence of class struggle (i.e., the result of workers' high wage demands) is open to question. This thesis is used as a political weapon against organized labor whenever the economy goes into recession. Somehow the implication is that if workers were to limit their wage demands, economic instability would be eliminated. The possibility that the LFTRP rules the actual process of accumulation makes that claim less persuasive. Perhaps it is not "unreasonable" wage demands, but the continual accumulation of capital imposed by

the competitive nature of capitalism, which periodically throws the economy into recession. In other words, it may well be that the very foundation of capitalism —i.e. the never-ending urge to engage in competition, is not as benign as traditional teachings would lead us to believe.

APPENDICES

APPENDIX I

THE EQUALITY BETWEEN VALUE AND PRICE UNDER SIMPLE COMMODITY PRODUCTION

Let us restate the assumptions which characterize a society of Simple Commodity Production: (1) The direct producers are in possession of their means of production —each worker is an independent producer; there is no labor market as such. (2) Each producer (worker) commercializes his or her own outputs. (3) It is implicitly assumed that every worker is capable of producing any commodity —this implies that the remuneration per hour of labor is the same in all economic activities.

Let us define:

p_i The price of commodity i (i=1,...,n)

γ_i The monetary cost of all the inputs other than direct labor used up per unit of commodity i (i=1,...,n)

l_i The amount (#of hours) of direct labor necessary to produce *one* unit of commodity i (i=1,...,n)

In these conditions, the *implicit* monetary remuneration per hour of labor (W) is given by

$$W=\frac{p_i-\gamma_i}{l_i},$$

from which it follows that

$$p_i=\gamma_i+Wl_i \qquad [1]$$

Now, the means of production and raw materials used to produce one unit of commodity i (i=1,...,n), and whose monetary cost is γ_i, are themselves produced with direct labor l_i' and other means of production and raw materials. Let the monetary cost of the latter be γ_i'. We have,

$$\gamma_i=\gamma_i'+Wl_i' \qquad [2]$$

Substitution of [2] into [1] yields

$$p_i=\gamma_i'+Wl_i'+Wl_i=\gamma_i'+W(l_i+l_i')$$

Similarly,

$$\gamma_i'=\gamma_i''+Wl_i'',$$

and hence,

$$p_i=\gamma_i''+Wl_i''+W(l_i+l_i')=\gamma_i''+W(l_i+l_i'+l_i''),$$

etc. Following this algorithm of *dated labor* we can "go back" until we reach the *original inputs*, i.e., those whose production has used up only direct labor. We will then have:

$$p_i=W(l_i+l_i'+l_i''+....)$$

where $(l_i+l_i'+l_i''+...)$ represents the total amount of labor, direct and indirect, incorporated in one unit of commodity i (i= 1,...,n) —l_i is the direct labor and $l_i'+l_i''+...$ is the indirect labor. Given any two commodities i and j, we have:

$$p_1 = W(l_1 + l_1' + l_1'' + \ldots)$$
$$p_j = W(l_j + l_j' + l_j'' + \ldots)$$

and hence,

$$\frac{p_1}{p_j} = \frac{l_1 + l_1' + l_1'' + \ldots}{l_j + l_j' + l_j'' + \ldots} = \frac{\text{amount of labor incorporated in one unit of commodity } i \ (L_i)}{\text{amount of labor incorporated in one unit of commodity } j \ (L_j)}$$

Now we can choose as *numeraire* any commodity and define as "unit" of the same commodity that amount of it which can be produced with *one* hour of labor (direct and indirect). In other words, we choose as numeraire an amount of commodity n such that $l_n + l_n' + l_n'' + \ldots = 1$. In this way, if the production of one unit of commodity i ($i = 1, \ldots, n$) requires L_i hours of labor, then its price in terms of the numeraire will be $L_i/1 = L_i$. Of course, we can choose as numeraire the amount of gold (*the money commodity*) which can be produced with one hour of labor (direct and indirect) —thus price=value.

APPENDIX II

DETERMINATION OF THE AVERAGE RATE OF PROFIT
(Circulating capital case)

From equation [3.a] we have: For $\pi = 0$, $p_2 = (1 - \omega l_1)/a_{21}$, therefore equation [3.a] intersects the p_2-axis at $(1 - \omega l_1)/a_{21}$. For $p_2 = 0$, $\pi = (1 - \omega l_1)/\omega l_1$, therefore equation [3.a] intersects the π-axis at $(1 - \omega l_1)/\omega l_1$. In addition, $d\pi/dp_2 < 0$ trivially, since as p_2

increases the numerator of [3.a] decreases and the denominator increases. Therefore, [3.a] is monotonically decreasing.

From equation [3.b] we have: For $\pi=0$, $p_2=\omega l_2/(1-a_{22})$, and hence equation [3.b] intersects the p_2-axis at $\omega l_2/(1-a_{22})$. For $p_2=0$, $\pi=-1$, and hence equation [3.b] intersects the π-axis at -1. In addition, $d\pi/dp_2=\omega l_2/(a_{22}p_2+\omega l_2)^2>0$, therefore equation [3.b] is monotonically increasing.

APPENDIX III

DETERMINATION OF THE AVERAGE RATE OF PROFIT
(Fixed capital case)

From equation [5.a] we have that for $p_2=0$ it is $\pi=(1-\omega l_1)/\omega l_1$, hence [5.a] intersects the π-axis at $(1-\omega l_1)/\omega l_1$. Also, for $\pi=0$ it is $p_2=(1-\omega l_1)/(\theta_1+a_{21})$, hence [5.a] intersects the p_2-axis at $(1-\omega l_1)/(\theta_1+a_{21})$. In addition, $d\pi/dp_2<0$ trivially, since as p_2 increases the numerator of [5.a] decreases and the denominator increases.

From equation [5.b] we have that for $p_2=0$ it is $\pi=-1$, and hence [5.b] intersects the π-axis at -1. Also, for $\pi=0$ it is $p_2=\omega l_2/[1-(\theta_2+a_{22})]$, hence [5.b] intersects the p_2-axis at $\omega l_2/[1-(\theta_2+a_{22})]$. In addition,

$$\frac{d\pi}{dp_2}=\frac{(1+\phi_2-\theta_2)\omega l_2}{[p_2(\phi_2+a_{22})+\omega l_2]^2}>0,$$

since $\phi_2>\theta_2$. Hence, equation [5.b] is monotonically increasing.

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